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November/December 1995

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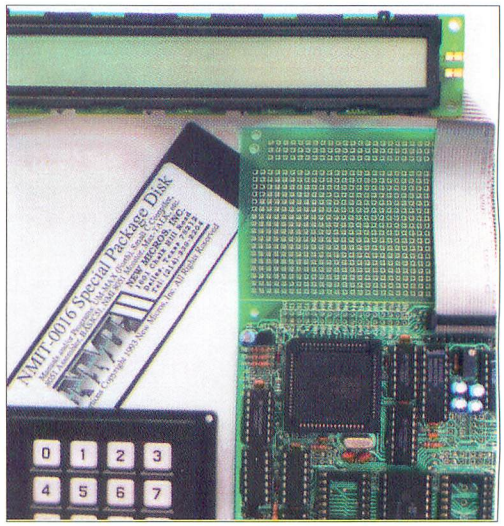

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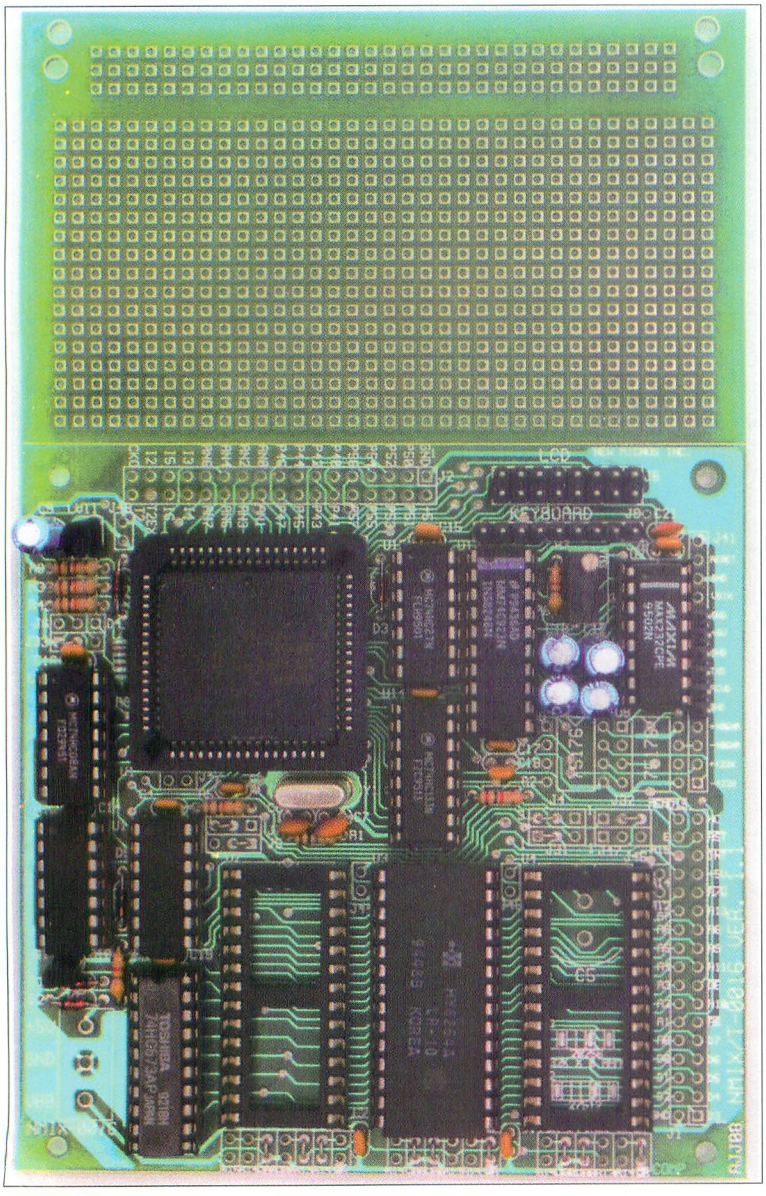

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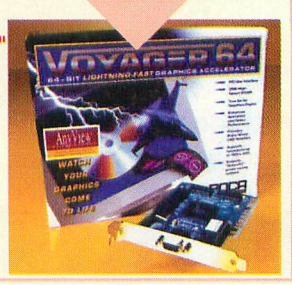

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BEN110	BOCALANcard TP (16-bit) RJ45 Only	64
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BCPRO850	850VA/570W LAN UPS (4 Outlets)	305
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IB4	ISOBAR, 4 Outlet, 6' cord, 2 Filter Banks	43	SUPER7 7 Outlet, 18,000A diag. LEDS,7' cord	19
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IB6ULTRA	ISOBAR 6 Outlet, 3 Filter Banks	56	LC-2400 2400W, 6 Outlet, 110V Conditioner	243
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ISOTELULT6	Modem/Fax, 6 Outlet,3 Filter Banks	61	MT6-PLUS MasterTouch, 6 Outlets diag. LEDs	82
ISOTELULT8	Modem/Fax, 8 Outlet, 4 Filter Banks	69	CC-16P Master Console 6 Out, 12' cord, RJ11	69

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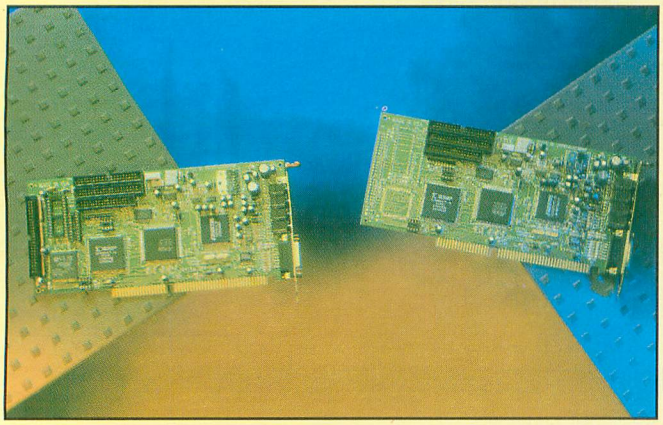

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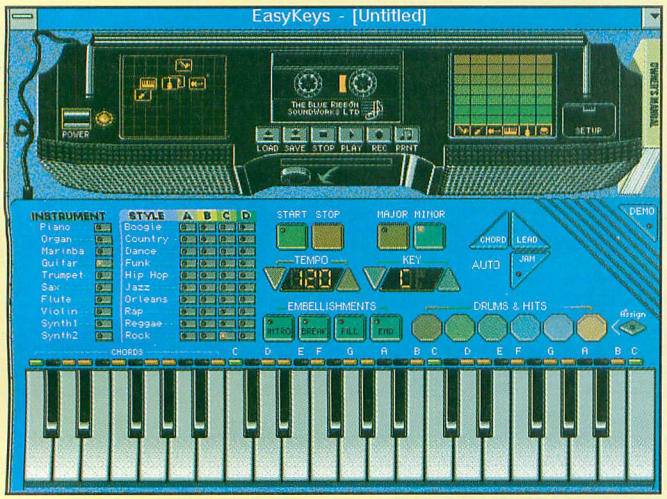

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In This Issue

If you're really into multimedia production—or just want to get into it—check out Tom Benford's "The Multimedia Sound Garden" beginning on page 36. In this feature article, Tom gives insider hints on putting together truly professional sound presentations to augment whatever video clips and stills you plan to use in a presentation. He goes on to describe some superb microphones and speaker systems and a particularly interesting sound processor you should seriously consider adding to your multimedia system.

Tom Fox's Part 1 of "A 68CHx11 EEPROM Programmer/Mini-Development System" beginning on page 14 gets you started with an introduction to the basics and construction details for this extremely popular MCU series. Then on page 24, Jonathan Michaels provides a solid introduction to "Interrupt Processing on the PIC 16C71" microcontroller from Microchip. Finally, T.L. Petruzzillis' "Build a PIC-Based MicroAlarm" on page 66 offers up a tiny, low-cost alarm that offers the kinds of features and flexibility you'd expect from a much more-elaborate-appearing and costly professional alarm system.

Need a new large-capacity hard drive? Before you make a buy decision, check out Hardin Brothers' "Large-Capacity Hard Drives" article beginning on page 20 to find out what you need to know to be a canny buyer and, almost as important, to install such a drive in your PC.

Michael A. Covington tells you how to exploit the bidirectional lines of your parallel printer port if it has them in his "Using Bidirectional Parallel Printer Ports" on page 32. Then it's off to "Getting to Know the RS-232 Standard" on page 58 with Fred Eady detailing the serial-port standard via its history, evolution and the technical details you need to know to successfully use it.

The use of SBCs and microcontrollers for monitoring and control purposes is on the rise. Jan Axelson introduces "A Network for Monitoring and Control Purposes" that lets you put together a multiple-unit system for more power and flexibility. The example Jan provides can serve as the foundation for building networks for specific needs. Turn to page 48 for the details.

Lurking somewhere on one of those floppy disks you borrowed, in a file you downloaded from a BBS or other on-line service or even in shrink-wrapped software can be a virus just waiting to run amok through your PC. To guard against such a possibility, it has become almost mandatory that you immunize your PC with a good anti-virus utility. Keep in mind that not all such utilities are equal, as the "Virus Vanquisher—*Dr. Solomon's Anti-Virus Toolkit*" review points out. Turn to page 44 for details on how *Dr. Solomon's* succeeded where other popular utilities failed.

Cover Photo By Tom Benford

Seasons Greetings & Happy New Year!

Editorial By Art Salsberg

Windows 95

We watched the path and development of *Windows 95* this year, much as people viewed the progress of hurricanes forming and moving in the Caribbean. Microsoft, however, had a surer hand than nature, down to the day it would certainly hit us.

It was a great buildup, costing Microsoft many megabucks (to make gigabucks). Along the way, *Windows 95* was battered by reviewers of Beta copies. A host of changes were made, as is fitting for pre-release of the final software. There will doubtless be plenty more in upgraded versions to come.

Substituting *Windows 95* for *Windows 3.1* will put pressure on your hardware requirements, as you've probably heard. You'll need at least a fast 486 CPU, 8M of user RAM memory and a spare 100M of hard-drive space. A better hardware arsenal would be a Pentium-based machine with 16M of RAM and a few hundred megabytes of spare hard-drive space. A hard drive with a gigabyte of storage to handle hefty programs that'll inevitably come would make sense to have or to get. For many, this really means starting anew with the purchase of a Pentium machine that's already loaded with *Windows 95*.

Windows 95 installation isn't a snap. It's supposed to take from a half hour to one hour. But reports indicate that you should set aside a few hours for this chore. And if you do it yourself, you'll, hopefully, have a CD-ROM drive so that you won't have to shuffle 13 floppy disks. Doing the latter exposes you to another problem: a virus that lurks on some hard-disk drives that erases or corrupts Disk 2 of the floppy installation set. To avoid it use the write-protect tab on Disk 2.

Also, some Microsoft *Word for Windows* 6.0 programs used with *Windows 95* are reported to harbor a damaging macro virus. Most anti-virus scans ignore it, unfortunately. You can get free detection software to combat this from Trend Micro Devices via Internet: http://www.teleport.com/trend/main.htm. Download it with any browser, such as *Netscape*. You can get a free *Norton Anti-Virus for Windows 95* download from CompuServe, too.

Beyond this, though, *Windows 95* is incompatible with loads of present programs. So check out known problem applications by dialing http//www.microsoft. com/windows/third-party/htm. Plan on buying updates of your favorite software programs that are *Windows 95*-ready, of course. In the interim, however, it would be nice to use older programs with *Windows 3.1* if they give you trouble in *Windows 95*. But this means installing *Windows 95* in a separate directory instead of over *Windows 3.1*. Doing this, however, will cause you a lot of work since custom settings won't be carried over to *Windows 95* from *Windows 3.1* and your applications.

Windows 95 has some very clear advantages, which have been noted in *MicroComputer Journal*. From my vantage point, I'd sooner live with what I've got nailed down for a while before migrating to *Win95*. I'd like to see more bugs cleared out and wait until a wide choice of 32-bit applications sanctioned by Microsoft with a *Windows 95* logo are available. And I'm talking as an individual. For a large LAN, I'd certainly hold my water for a while. It'll take another year before the smoke clears and one really knows how much computing power and new software would be desirable to tap the full power of *Windows 95*. By that time, maybe *Windows NT* would be the smart move.

Of course, if you have the recommended hardware and an urgent reason to gravitate to *Windows 95*, such as having the need to run multiple programs or take advantage of *Win 95*'s other special features, by all means, do so. Don't discount this new operating system just because it's new and it's the first version to come out.

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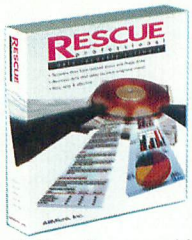

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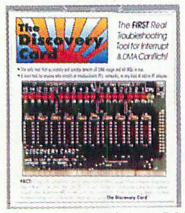

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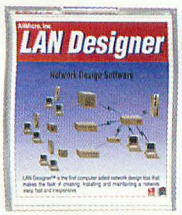

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FREE TO ROAM. Eiger Labs (Santa Clara, CA) debuts its PC Card-style infrared (IR) wireless local-area network (LAN) adapter that enables a portable PC to log onto an office network. By using "diffuse-light" technology, sending and receiving computers operate without being aimed directly at each other, even going through walls. A portable computer equipped with the adapter can share such network resources as network printers, mass storage and communication devices without wiring. It's compatible with popular network software, such as Novell Netware, Artisoft LANtastic and Microsoft's Windows for Workgroups. The Type II PC Card, priced at $429, operates on any IBM or compatible computer with the appropriate PCMCIA slot and Card and Socket Services version 2.0 or later.

Another new wireless device is Adaptec's AIRport IR adapter for wireless I/O use. AIRport 1000 ($89) includes an IR adapter to upgrade a notebook PC that doesn't have a built-in IR port. It snaps onto the serial port to provide an IR link to other IR-equipped devices. AIRport 2000 ($119), in turn, includes an IR port adapter for a desktop PC. It has three power options: serial port, ac adapter or battery. Each kit includes TranXit for Windows 3.1, file-transfer and synchronizing software to copy and move files from one system to another. Data-transfer rates are up to eight times faster than 14.4K modems.

MORE VIRUS THREATS. A new computer virus can hit Microsoft Word for Windows Version 6, including Word running under Windows 95. Named WinWord.Concept, the anti-virus research team at S&S Software (Dr. Solomon's Anti-Virus Toolkit) says it's the world's first virus to infect data files by installing macros that infect documents instead of executable code. The new virus, also known as WW6Macro and Prank Macro, can infect Word 6 documents (with the .DOC extension) and the NORMAL.DOT global template or any template designated as a global default. It travels via electronic mail. Users can detect the virus via Microsoft Word, selecting Tools/Macros for the presence of macros AAAZFS, AAAZAO, AutoOpen, Payload and FileSaveAs. If all are present, WinWord 6 is infected. Users of Dr. Solomon's Anti-Virus Toolkit can download detection software for the new virus from its BBS at 617-229-8804; via Internet at support@us.sands.com or via CompuServe at GO SOLOMON. Call 617-273-7400 for information on how to remove the virus.

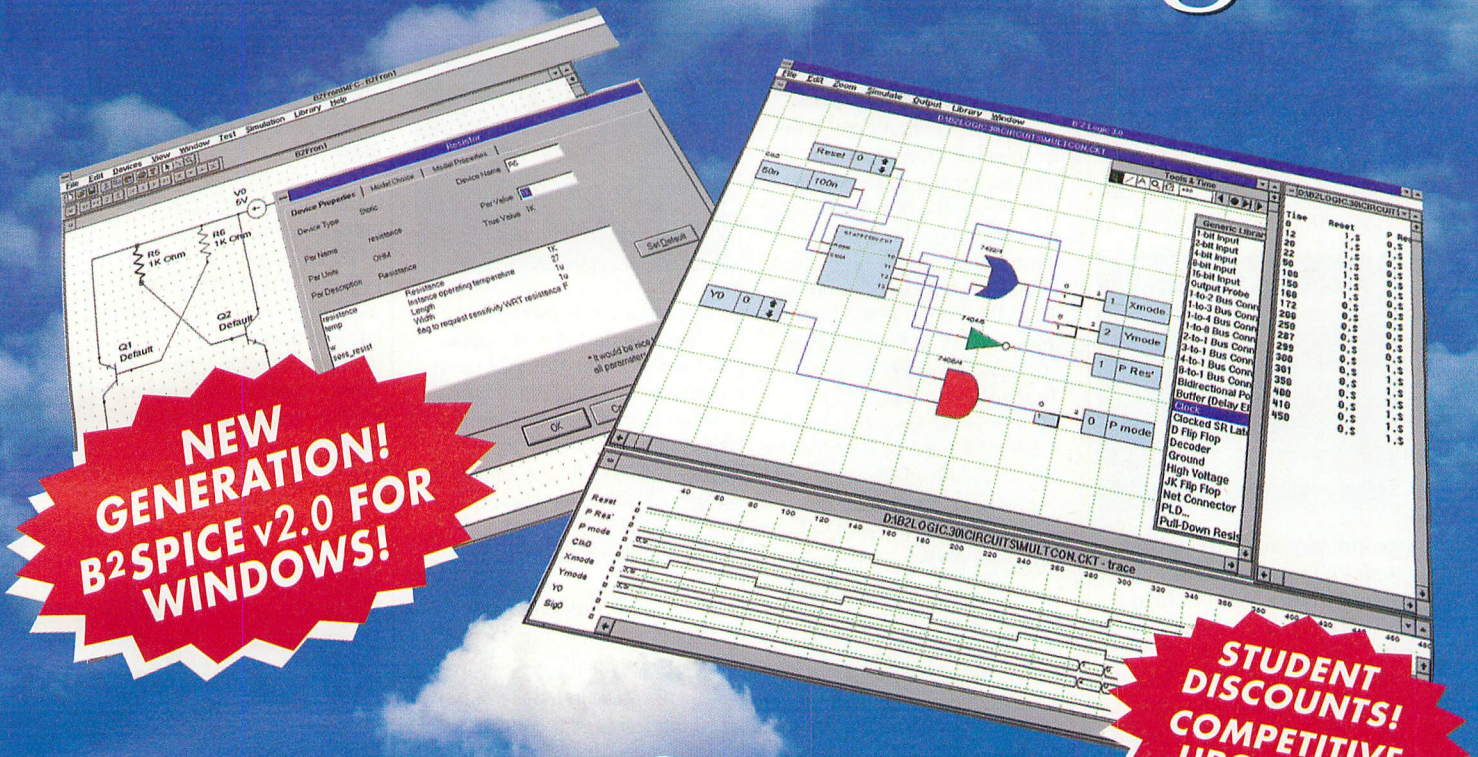
S&S also offers a scanner to help users resolve a problem that prevents many users from successfully installing Windows 95. Disk 2 can be corrupted during installation if the computer is infected with a boot-sector virus. Users can obtain the scanner from S&S by downloading the file "DSAVT751.ZIP" from the company's CompuServe forum and WWW site http://www.drsolomon. com. They can also download it from Ziffnet's Tech Tips forum (Go Ziffnet). The download-able version of the scanner, FindVirus, must be unlocked.

NEW OPERATING SYSTEM. AT&T announced that its new operating system, Plan 9, is available for research and educational use. Named for the sci-fi cult movie, "Plan 9 From Outer Space," it was designed by the inventors of the UNIX system. It's a distributed system that will generally use terminals on users' desks and file servers. It's designed to work with networking products in which very small size and efficiency are essential. Not competing with Windows or Unix, the Plan 9 OS currently controls the computer that maintains parts of the Bell Labs World Wide Web service and has already been licensed to some 200 colleges and universities. The product, including source code, costs $350. For more information, call 1-800-462-8146.

EXPLORING. Impatients Publications (612-822-1799) announced a new software application for investigating fuzzy logic. Called TeachFuzz, it's a learning tool that instructs users on how to design, construct and simulate a given system. It also aids in producing fuzzy logic-based controllers. It also comes with a tutorial and a user's manual and needs at least MS-DOS 5.0 and a 386 machine. An Apple Macintosh version requires a minimum of a Macintosh Plus running MultiFinder and System 6.0.7. TeachFuzz costs $24.95 plus $2 S&H.

Superscape Inc. (415-812-9376) announced that 27 Superscape VRT software packages were acquired by George Washington University's School of Business and Public Management for use in graduate courses in virtual reality and for part of the advanced technologies course required for all MBA students. The software runs on a 486 or Pentium-based computer. No additional graphic cards or graphic accelerators are required.

Circuit Simulation Soars to New Heights



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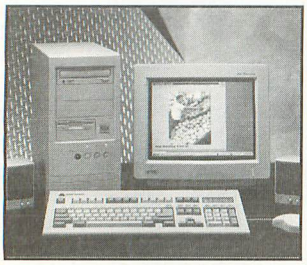
HARDWARE

120-MHz Pentium

Micro Express' MicroFLEX-PCI/P120 120-MHz Pentium PC offers burst mode cache for greater data-transfer rates. It also includes EDO RAM, Plug and Play Flash BIOS, and built-in dual-channel PCI/EIDE controller. Standard features include 15" video monitor, 16M of EDO RAM, 4X CD-ROM drive, selectable shadowing of both system and video BIOS and others. The



proprietary motherboard has four PCI expansion slots and four 16-bit ISA slots. Up to 128M of RAM is supported on the motherboard. $2,999. *Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705; tel.: 714-852-1400; fax: 714-852-1225.*

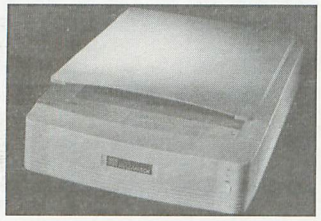
CIRCLE NO. 1 ON FREE CARD

4X CD-ROM Drive With Sound Card

Micro Solutions CD-ROM Backpack is a quad speed CD-ROM with a built-in sound card that requires no interface cards because it attaches to the printer port. It automatically recognizes Enhanced Parallel Ports and IEEE1284 ports. The Backpack is MPC 2-compliant when running on an EPP port. The motorized tray requires no caddie.

The 16-bit sound card includes 20-voice FM synthesis, four FM operators and 128 MIDI instruments. Line and auxiliary inputs and microphone jacks are included on the drive. $659. *Micro Solutions, Inc., 132 W. Lincoln Hwy., DeKalb, IL 60115; tel.: 815-756-3411; fax: 815-756-2928.*

CIRCLE NO. 2 ON FREE CARD



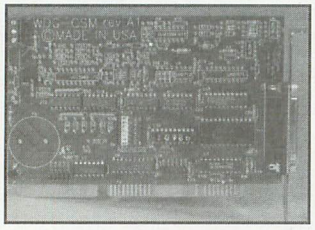
30-Bit Scanner

The 30-bit Z1-600 single-pass flatbed color scanner from Tamarack Technologies can distinguish more than one billion colors and 1,024 shades of gray. Its 330 x 600 dpi optical resolution enables it to produce a 300-dpi, 30-bit color, letter-size scan in 35 seconds. TWAIN drivers scan directly into any TWAIN-compatible application. $699. *Tamarack Technologies, Inc., 1521 Orangewood Ave., Orange, CA 92668; tel.: 714-744-3979; fax: 714-744-4582.*

CIRCLE NO. 3 ON FREE CARD

Watchdog Timer

The Industrial Computer Source Model WDT501-P multi-function watchdog timer card is designed for use in PC/AT-based data-acquisition and control applications. It offers the host computer protection from temporary malfunctions

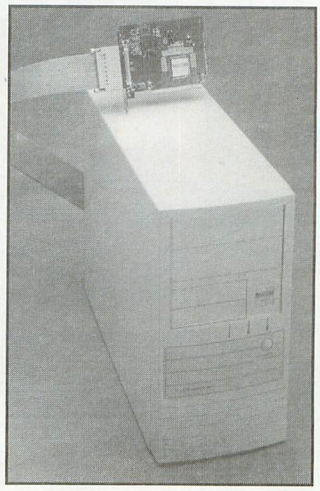


and augments its watchdog functions with a number of internal host diagnostics, including voltage and temperature monitoring and others. $195. *Industrial Computer Source, 9950 Barnes Canyon Rd., San Diego, CA 92121; tel.: 800-523-2320; fax: 619-677-0895.*

CIRCLE NO. 4 ON FREE CARD

PCI Expansion Unit

Bit 3's Model 2101 PCI Expansion Unit transparently adds seven additional 32-bit PCI slots to a host computer. Throughput to 132M/sec. and zero-wait-state operations are supported. The Model 2101 consists of a Bit 3 host PCI



card and a mini-tower-style cabinet. Included in the cabinet are an eight-slot PCI motherboard, PCI backplane controller card, five expansion bays and a 250-watt power supply. $995. *Bit 3 Computer Corp., 8120 Penn Ave. S., Minneapolis, MN 55431; tel.: 612-881-6955; fax: 612-881-9674.*

CIRCLE NO. 5 ON FREE CARD

AI Controller

Angelus Research has a multitasking intelligent controller that mimics the three levels of intelligence found in the human brain. Software embedded in this system gives robots and machines the ability to operate in unstructured environments without prior knowledge or programming. Using motor/sensor fusion similar to that of a human, the software makes critical decisions in realtime. Using an English-like language, you can immediately and interactively program the system. $395. *Angelus Research Corp., 6344 Sugar Pine Cir., Angelus Oaks, CA 92305; tel.: 909-794-8325.*

CIRCLE NO. 6 ON FREE CARD

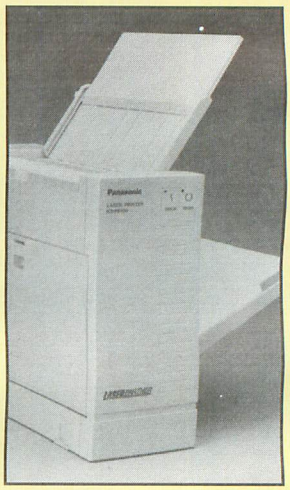
Fast Hard Drive

Super Drive from Sibex is an external hard drive that permits continuous high-speed transfer and storage of large amounts of data. It includes a proprietary interface and power supply and is addressed through a standard SCSI II interface and RS-232 port. The technology permits transfer

Ultra Compact *Windows* Printer

Panasonic's KX-P6100 mini-tower-sized laser printer is designed for *Windows* users. This 6-ppm unit employs a new proprietary laser engine and utilizes the processing power of a PC to produce a document. Though rated at 300 dpi, print quality is improved by patented edge enhancement technology (EET). Image quality is also improved through a photo-enhancement feature.

Windows utility software provides a host of features, including two up/four up that lets you print two or four pages on a single letter-sized sheet; manual duplexing; reverse-order printing; and an overlay feature. An interactive Show Me utility provides an animated guide to printer problems.



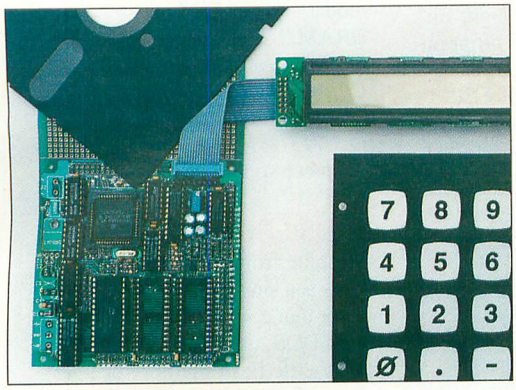
The KX-P6100 conserves energy by slipping into sleep mode after 15 minutes of inactivity. The printer conserves toner by incorporating an all-in-one cartridge that lets you refill toner through a special no-spill system. A multi-purpose paper tray accommodates up to 100 sheets of 20-pound paper, 10 envelopes, 30 labels or 30 transparencies. $400. *Panasonic Communications & Systems Co., Two Panasonic Way, Secaucus, NJ 07094; tel.: 201-348-7000.*

CIRCLE NO. 7 ON FREE CARD

68HC11 Controller & Languages

Program it in C

$99



or Assembly

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Low Cost Development Package: Controller + Languages + Manuals on disk included!

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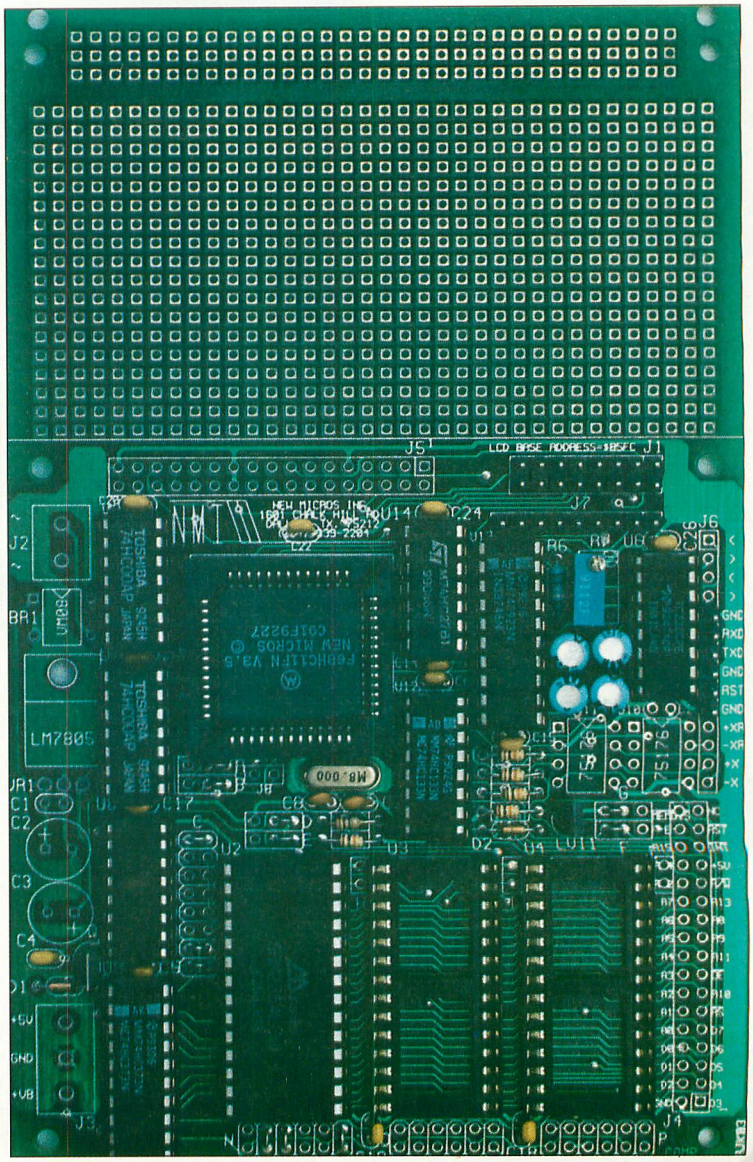
The NMIT-0020 Single Board Computer is perfect for dedicated controller with convenient interfaces for LCD displays and keypad. Intelligent LCD's up to 2 lines by 80 characters and matrix keypads up to 4x5 can be used. The processor is the popular F68HC11 with many features, including SCI and SPI serial channels, 8-bit 8-ch. A/D, 20 available I/O lines, Watch Dog Timer, 1/2K EEPROM and Max-FORTH w/Floating Point Package embedded in 12K internal ROM. SBC expands F68HC11 providing 3 28-pin JEDEC sockets for 8-32K RAMs, ROMs, EPROMs, EEPROMs, etc. RS-232 conversion supplied. Requires external regulated supply: 5V at ~30 mA. Based on NMIX-0020 board, so, many features may be added as desired by the user (or by factory - fully configured NMIX-0020 Ad-special available @ $145, call for details).

Languages supplied on accessory disk: Small C, Basic, and Assembler. FORTH resident on chip (may be disabled). Languages come with manuals on disk. (Printed manuals extra.) Communications utility, MAXTALK included to allow PC clone to act as terminal for download and development. WIPE utility included allows internal ROM, EEPROM, WDT to be enabled/disabled, and EEPROM to be erased. Manuals on disk: UM-MAX Max-FORTH Users Manual, HM-20 NMIX-0020 Hardware Manual, Small C manuals with examples, BASIC11E9 Manual.

SBC and utility disk - $99. (Keypad and LCD not included. Available separately.) Great value. Call today! New Micros, Inc. Tel: 214-339-2204, Fax: 214-339-1585.



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and storage of data at rates up to 10M/s for files up to 2G in length, accomplished in a continuous mode, rather than through bursting. *Sibex, Inc., 1040 Harbor Lake Dr., Safety Harbor, FL 34695; tel.: 813-726-4343; fax: 813-726-4434.*

CIRCLE NO. 8 ON FREE CARD

Sound Board Modem

Logicode Technology's QuickWave DSP Sound/Voice Mail/Fax Modem combines a sound card with a 19,200-bps data/14,400-bps fax modem and voice mail, all on one card. The sound card features 16-bit playback and record and plays and records messages from 5 to 44.1 kHz and encodes and decodes 16K and 24K bytes per second subBand speech. The card is SoundBlaster-compatible and supports MPEG II audio compression and decompression.

Also included are Mitsumi, Panasonic, Sony and Enhanced IDE interface connectors for CD-ROM drives. Voice mail features a digital answering machine and message center. It screens and forwards calls, uses caller ID, creates message boxes with remote access and retrieval and supports pagers. The modem automatically distinguishes between a fax, data and voice transmission and supports V.42, V.42bis, V32-bis and MNP 1-5 protocols. Fax capability includes full compatibility with Group 3 fax machines. $389.95. *Logicode Technology, Inc., 1380 Flynn Rd., Camarillo, CA 93012; tel.: 805-388-9000; fax: 805-388-8991.*

CIRCLE NO. 9 ON FREE CARD

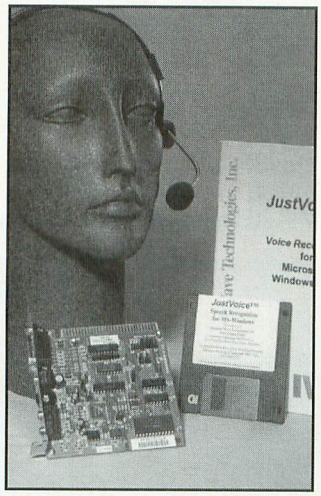
Noise Monitor

No Noise from Merritt Computer Products is a computer accessory that quiets computer cooling fans. The component installs inside the power supply between the fan and power-supply board. Instead of the fan running at full speed, No Noise monitors the computer's cooling needs and regulates fan speed accordingly. $49.95. *Merritt Computer Products, Inc., 5565 Red Bird Center Dr., Ste. 150, Dallas, TX 75237; tel.: 214-339-0753; fax: 214-339-1313.*

CIRCLE NO. 10 ON FREE CARD

Voice Commands for *Windows*

Just Voice for *Windows* from Integrated Wave Technologies offers voice command and control for all popular *Windows* software. The package includes the software, an optimized sound card and a headset-style microphone.

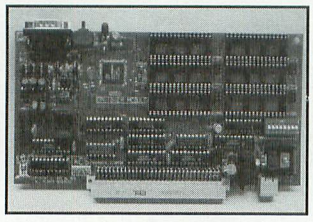


Just Voice is a speaker-dependent, sound-based recognition system that requires only one training pass per command. It offers an unlimited vocabulary, is resistant to background noise and is claimed to operate with a recognition accuracy of greater than 98%. $175. *Integrated Wave Technologies, Inc., 4042 Clipper Ct., Fremont, CA 94538; tel.: 510-353-0260; fax: 510-353-0261.*

CIRCLE NO. 11 ON FREE CARD

186EM Module

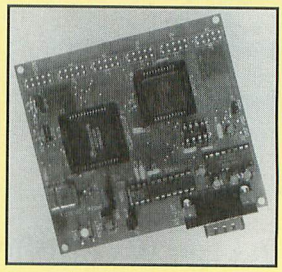
ACS' CPU186EM controller module for the open ACS-BUSS offers 16-bit operation at speeds up to 40 MHz and includes both flash memory and static RAM. An on-board serial port lets you connect to a terminal, computer or other operator interface. *ACS, 4276 Lago Way, Sarasota, FL 34241; tel.: 813-377-5775; fax: 813-378-4226.*



CIRCLE NO. 12 ON FREE CARD

68HC11 SBC

LDG Electronics' SBC-8K 68HC11-based single-board computer employs the Xicor X68C75 processor, 8K of EEPROM and Port Replacement device. Included are an RS-232 port, eight eight-bit A/D converters, 16 programmable and eight fixed I/O lines, 8,704 bytes of EEPROM, 272 bytes of RAM, and a socket for an optional 8K serial EEPROM.



Operation is from a single 5-volt source, and current consumption is less than 60 mA. The package includes *CodeLand+* 2.0 development software and source files for all sample programs. $79.95. *LDG Electronics, 1445 Parran Rd., St. Leonard, MD 20685; tel./fax: 410-586-2177.*

CIRCLE NO. 13 ON FREE CARD

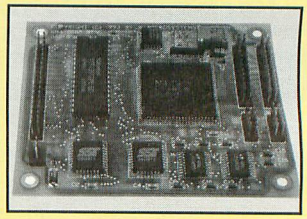
Pentium SBC

The P590 CPU board from Texas Microsystems is a 90-MHz Pentium-based board for PCI/ISA or ISA passive-backplane systems. In addition to the processor, the board features a Fast SCSI-2 host adapter, two RS-232C serial ports, Centronics compatible Enhanced Parallel/Capabilities port, IDE hard-and floppy-disk controllers, Phoenix BIOS and 256K of SRAM secondary cache (expandable to 512K). Four SIMM sockets accommodate up to 128M of DRAM. $2,695. *Texas Microsystems, Inc., 5959 Corporate Dr., Houston, TX 77036; tel.: 713-541-8200; fax: 713-541-8226.*

CIRCLE NO. 14 ON FREE CARD

DOS SBC

Flashlite from JK Microsystems is a single-board computer that comes complete with DOS, utilities and a read/write flash-memory disk drive. A V-25 Plus processor provides two serial ports, two DMA channels, two timers, 24 parallel I/O lines, five

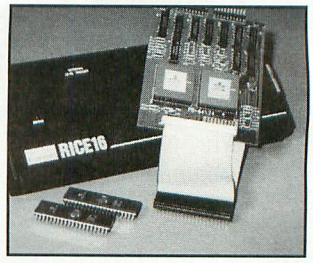


interrupts and eight analog comparators. Flashlite also contains 512K of RAM and 256K of flash memory. Preloaded utility software includes a flash-disk format program, X-modem file upload program, text editor and Tiny BASIC interpreter. $149. *JK Microsystems, 1275 Yuba Ave., San Pablo, CA 94806; tel.: 510-236-1151.*

CIRCLE NO. 15 ON FREE CARD

PIC Probe Cards

The PB-64 and PB-74 probe cards from Advanced Transdata support the PIC16C64 and PIC16C74, respectively. The cards work with the company's RICE16 PIC realtime emulator, which also supports the PIC16C5x family and other PIC16Cxx microcontrollers.



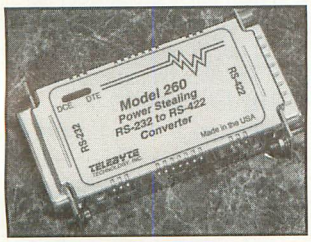
Utilizing the emulator and bond-out chips from Microchip Technology, the PB-64 and PB-74 support realtime emulation of the device to 12 MHz.

Each probe card has an emulator cable that plugs directly into a 40-pin DIP socket in the target application. The cards connect to the RICE16 via header pins. RICE16 links to an IBM or compatible PC via the parallel printer port. $475 each. *Advanced Transdata Corp., 14330 Midway Rd., Ste. 128, Dallas, TX 75244; tel.: 214-980-2960; fax: 214-980-2937.*

CIRCLE NO. 16 ON FREE CARD

RS-232-to-RS-422 Converter

Telebyte's Model 260 Interface Connector is an RS-232-to-RS-422 converter that derives its operating power from the Transmit Data signal presented to the RS-232 interface. It accommodates full-duplex signals at data rates up to 19.2K bps without requiring dc or ac power. $99. *Telebyte Technology, Inc., 270 Pulaski Rd., Greenlawn, NY 11740; tel.: 516-385-7060; fax: 516-385-8184.*



CIRCLE NO. 17 ON FREE CARD

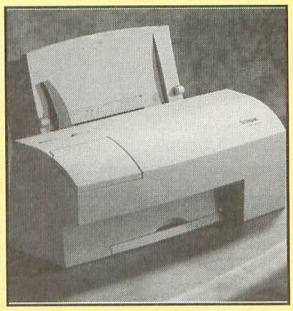
CD-ROM Changer

Pioneer's DRM-624X six-disc CD-ROM changer features a high-speed 4.4X drive, a data transfer rate of 676K/s and average access time of 150 ms. The unit is capable of changing color. Included with the printer is the ColorFine 2 *Windows* printer driv- er. $349 (street price). *Lexmark Int'l., Inc., 55 Railroad Ave., Greenwich, CT 06836; tel.: 800-358-5835.*

CIRCLE NO. 18 ON FREE CARD

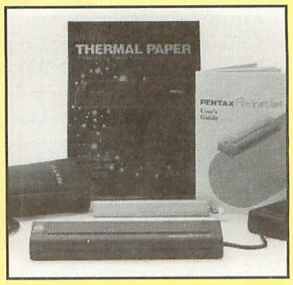
Color Inkjet Printer

Lexmark's WinWriter 150c is a dual cartridge color inkjet printer offers 600 X 300-dpi resolution in both color and true black. It prints up to three pages per minute in black draft mode and at two to seven minutes per page in



PocketJet Printer

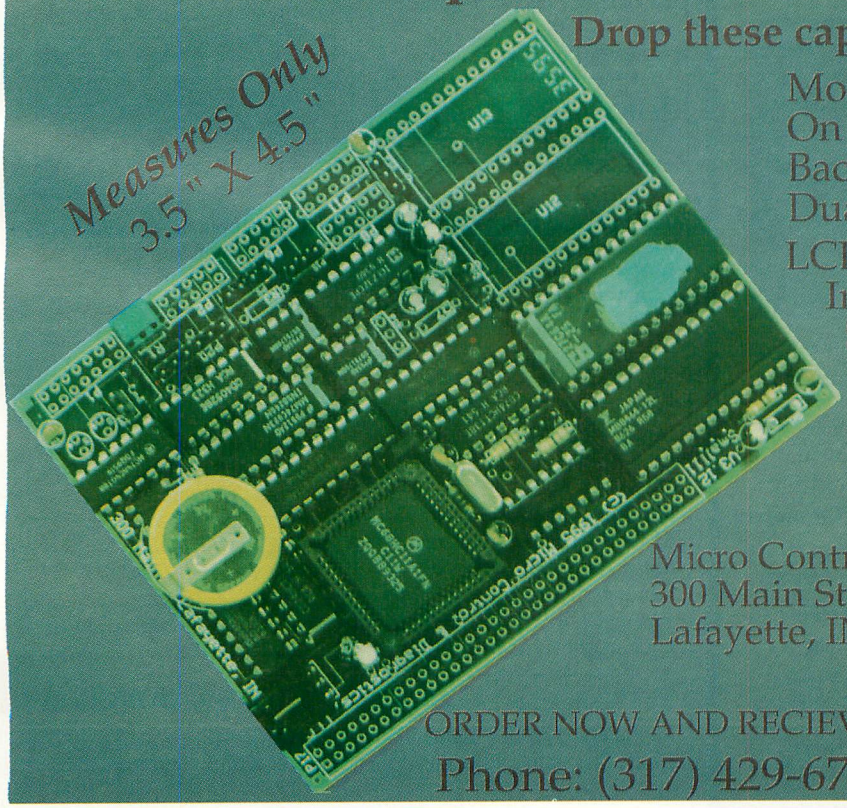
Pentax Technologies' new PocketJet printer now supports legal-size page printing. The printer, which weighs just over a pound, features direct thermal print technology, 300-dpi resolution and battery operation. It can print up to three pages per minute.



An ac adapter/charger is included. Thermal paper is required. $529. *Pentax Technologies Corp., 100 Technology Dr., Broomfield, CO 80021; tel.: 303-460-1600; fax: 303-460-1628.*

CIRCLE NO. 19 ON FREE CARD

A Full Featured HC11 Controller That Doesn't Require Its Own Zip Code.



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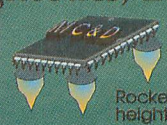

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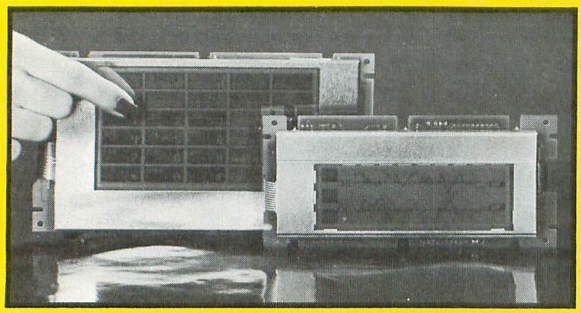

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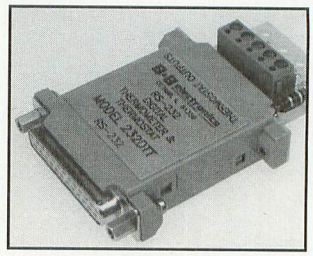
ing discs in 5 seconds or less and supports all major CD standards and formats. $795. *Pioneer New Media Technologies, Inc., 2265 E. 220 St., Long Beach, CA 90810; tel.: 310-952-2111; fax: 310-952-2990.*

CIRCLE NO. 20 ON FREE CARD

RS-232 Thermometer

B&B Electronics' Models 232DTT and 485DTT digital thermometers enable you to take temperature measurements and program thermostat settings in nonvolatile registers. The RS-232 version can be port powered from hand-



shake lines set high. The RS-485 version requires an external 12-volt dc power supply. $59.95/$64.95. 232/485. *B&B Electronics, 707 Dayton Rd., PO Box 1040, Ottawa, IL 61350; tel.: 815-434-0846; fax: 815-434-7094.*

CIRCLE NO. 21 ON FREE CARD

Total I/O Card

FarPoint's all/IO card for PCs features four 16550-compatible serial ports, two EPP/ECP 1284 parallel ports, an integrated dual-channel IDE controller and floppy-drive controller. The IDE controller supports up to four hard drives or a combination of hard drives and CD-ROM drives. The floppy controller supports four drives ranging in capacity from 360K to 2.88M. All/IO also supports Hewlett-Packard's Bi-tronics interface. $139. *FarPoint Communications, 104 E. Ave. K-4, Ste. F, Lancaster CA 93535; tel.: 805-726-4420; fax: 805-726-4438.*

CIRCLE NO. 22 ON FREE CARD

X-10 Voice Module

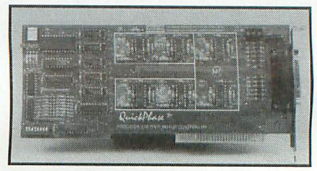
IntellaVoice from Intella-Home is a stand-alone mes-

sage controller for X-10-based home-automation systems that lets you create custom announcements to accom- pany key X-10 events. A built-in microphone and automatic-gain circuits produce high-quality, natural-sounding voice reproduction. You can record up to eight nearly 10-second-long custom announcements. An on-board processor monitors the power line, using the included X-10 TW523 interface, for key event commands and then plays the correct announcement for that event. $379. *Intella-Home, Inc., PO Box 780392, Sebastian, FL 32958; tel.: 407-589-0980.*

CIRCLE NO. 23 ON FREE CARD

Motion Controller

QuickPhase from MicroKinetics is a stepper-motor controller that contains on-board translators and power drivers for up to three axes. The card plugs into any eight-bit ISA bus slot. Features include programmable acceleration/decel-



eration, automatic over-temperature protection, end-of-travel detection on all axes, two auxiliary outputs per card and a "safety shield open" interrupt. Provided subroutine libraries support C and *QuickBasic* and include linear and circular interpolation, ramping, keyboard interactive jog and electronic gearing. *MicroKinetics Corp., 1220-J Kennestone Cir., Marietta, GA 30066; tel.: 404-422-7845; fax: 404-422-7854.*

CIRCLE NO. 24 ON FREE CARD

Remote-Control Trackball

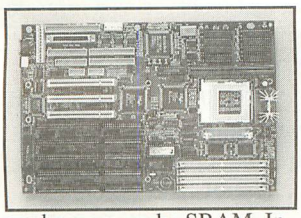
Presentation Electronics' Trac-

Pro is a remote-control device with an integrated trackball for on-screen computer and multimedia presentations and training. The remote combines a 16-mm trackball with 18 backlighted buttons that can be customized with up to 32 keyboard and mouse commands. TracPro installs on any mouse port and functions like a wired trackball. Included with the device are *TracPro Plus* software and ProShow, a presentation-enhancement utility. $199. *Presentation Electronics, 4320 Anthony Ct. #1, Rocklin, CA 95677; tel.: 916-652-9281; fax: 916-652-9286.*

CIRCLE NO. 25 ON FREE CARD

Pentium/SCSI Motherboard

Quick Technology's P54TS Pentium PCI all-in-one motherboard combines Adaptec SCSI and Intel Triton technologies. It supports EDO/Burst DRAM, COAST (Cache On A STick) and pipelined burst



synchronous cache SRAM. Included are three PCI slots, five ISA slots, two 16550 UARTs, a PS/2 mouse port, two IDE channels with Bus Master/DMA and an EPP/ECP IEEE 1284 printer port. $495 (CPU and memory aren't included). *Quick Technology Corp., 1542 Edinger Ave., #B, Tustin, CA 92680; tel.: 714-258-4500; fax: 714-258-4508.*

CIRCLE NO. 26 ON FREE CARD

Singing Mouse

Media Mouse from Media Depot is a two-button mouse that works with a sound card and speakers to play back prerecorded sounds. The mouse can generate music, animal sounds and other sounds when moved or when the cursor touches the edge of the computer display. Bundled with Media Mouse are three CDs: *Greatest Paper Airplanes*, *Pinball Crystal Caliburn* and *Mega Race*. $69. *Media Depot, 209 Erie St., Pomona, CA 91768; tel.: 909-629-2597; fax: 909-629-7084.*

CIRCLE NO. 27 ON FREE CARD

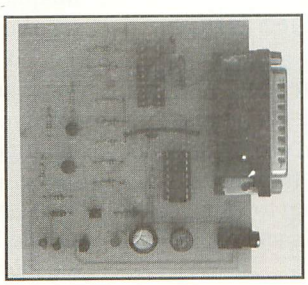
Cordless Keyboard

CASCO's Light Link full-featured Cordless Keyboard utilizes infrared technology. A base station that receives the line-of-sight infrared signal connects to a standard AT keyboard port. A PS/2 adapter is also included. The keyboard is powered by an Ni-Cd battery pack that provides more than eight hours of continuous operation on a full charge. $199.95. *CASCO Products, Inc., 375 Collins Rd. NE, Ste. 115, Cedar Rapids, IA 52402; tel.: 800-793-6960; fax: 319-393-6895.*

CIRCLE NO. 28 ON FREE CARD

PIC Programmer

PIC-1 from ITU Technologies is a programmer for Microchip's PIC16C6x/7x/8x family of microcontrollers. It's designed to work with an PC/compatible host. An 18-pin socket is provided for programming 18-pin PIC devices, and an expansion header is provided for adapters and in-system programming of EEPROM-based PICs. The programmer is supplied with a



(Continued on page 73)

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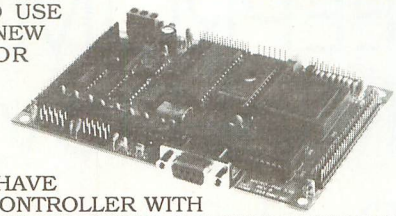

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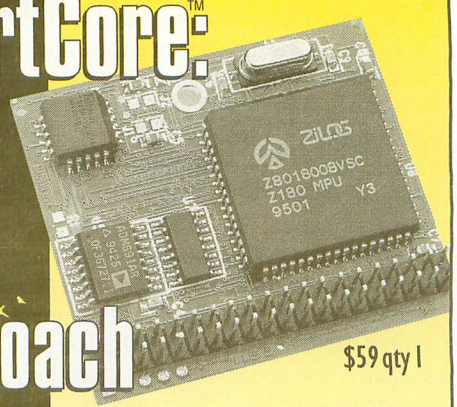

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CIRCLE NO. 96 ON FREE INFORMATION CARD

By Thomas R. Fox

A 68HCx11 EEPROM Programmer/ Mini-Development System Part 1

Basics and construction

Originally designed to be used by the world's largest automobile company in its second and third generation of computer-controlled cars, Motorola's 68HC11 MCU now has wide usage, including a host of them dreamed up by sophisticated robotics hobbyists. The reason behind the HCx11's rapid rise to stardom is multi-fold.

To begin with, the HC11 is downward software-compatible with Motorola's first MPU, the popular 6800. Many designers, engineers and hobbyists cut their baby microprocessor teeth on the Heath Company's first and most-famous ET-3400 microprocessor trainer. First introduced in 1978, this trainer was based on the original 6800. Heath still sells the nearly-identical ET-3400A trainer, based on the nearly identical 6808.

Another even-more-important reason for the HCx11's popularity is the chip's extreme versatility. The HCx11 contains just about everything needed, in one tiny package, to create an MCU-controlled device. Motorola's comprehensive free support for the HCx11 and similar chips has also widened its popularity. You can get some idea about this immense and free support by logging onto Motorola's Freeware BBS. Two important freebies from Freeware are a basic, yet complete, cross-assembler and a sophisticated BUFFALO monitor program for the HCx11. Since the monitor is free and no royalties are required, the cost of the kit for the MAGPRO-11 described here is kept to a bare minimum because little time was required for software development. All you need is the hardware, such as the MAGPRO-11, and a few tricks using the BUFFALO monitor.

In this series, you'll primarily be concerned with only the relatively common and inexpensive MC68HC11A1FN, though I'll also give you a brief look at the relatively hard-to-find MC68HC811E2FN. The primary difference between the two is the size of the internal EEPROM. The HC11 has 512 bytes of EEPROM, and the HC811 has 2K bytes. In this series, you'll make good use of this EEPROM. In this first installment, I describe MAGPRO-11, which functions as both an EEPROM programmer (up to an 8K EEPROM) and an HCx11 mini-development system.

In addition to the EEPROM, the 52-pin PLCC-packaged eight-bit 68HC11A1FN has 256 bytes of RAM, an eight-channel A/D converter, on-board SCI (and SPI), several input/output ports and a multitude of other features I won't mention here because they won't be used in the projects I'll describe.

Modes of Operation

Although four modes of operation are provided for in the HCx11—normal single-chip, bootstrap single-chip, normal expanded and special-test expanded—it's helpful for a better understanding of the chip to view it as if it has only single-chip and expanded modes.

When the HCx11 is in expanded mode, it functions similar to a standard microprocessor that has a multiplexed address and data bus (as in the 6801/6803). For instance, with addition of a 74HC373 or 74HC573 tri-state octal D latch, used to separate the data bus from the low-order address bus, you can treat the HCx11 nearly identically to the 6800. However, when the HCx11 is placed in single-chip mode, things change significantly. Suddenly, the data and address buses appear to be dead! In fact, unless you've had experience with MCUs in single-chip mode, you'd swear that the HCx11 is a tiny useless fragment of ultra-pure silicon!

In this series, I'll concentrate on single-chip mode, although MAGPRO-11, described in this first part, uses primarily expanded mode. Keep in mind that MAGPRO-11 is a tool for programming the HCx11's EEPROM and that it serves as a mini-development system. In upcoming issues, I'll describe construction and use of a MAGTROLL-11 simple and inexpensive multipurpose MCU controller board and a practical application of MAGTROLL-11, which is a unique wind-direction indicator that requires no moving parts and provides a good practical demonstration of some amazing things you can do with relatively simple designs that use the intelligence of the basic eight-bit mirocontroller unit.

The most-economical way to design simple HCx11-based projects is to use the internal EEPROM and initially place the MCU in single-chip bootstrap mode. In this mode, it's possible

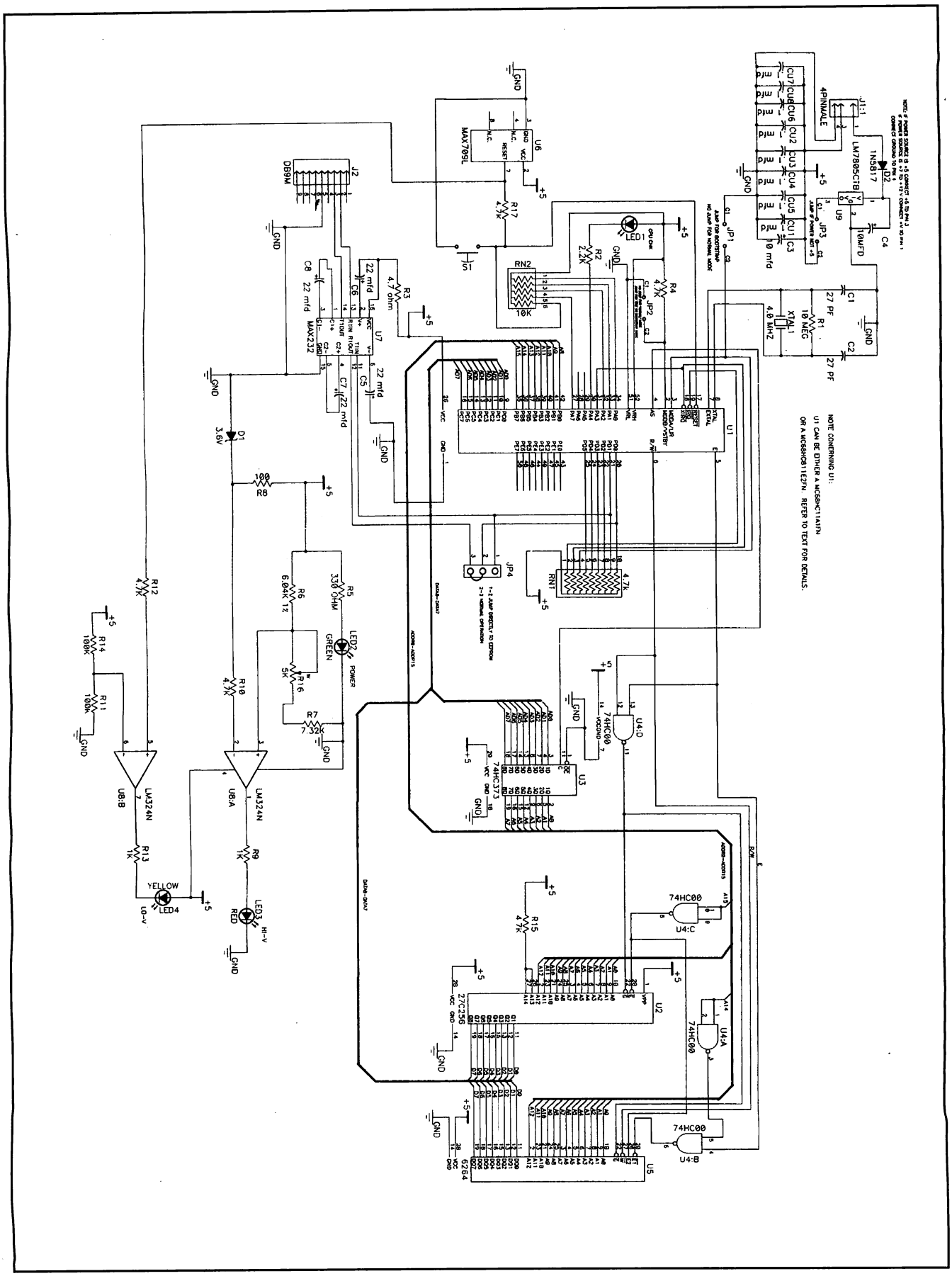

Fig. 1. Complete schematic diagram of MAGPRO11 circuitry.

PARTS LIST

Semiconductors

D1—1N4729A, 1-watt, 3.6-volt zener diode
D2—1N5817 Schottky barrier rectifier
LED1, LED4—Low-power yellow light-emitting diode
LED2—Standard green light-emitting diode
LED3—Low-power red light-emitting
U1—52 pin solder-tail PLCC socket (Digi-Key Cat. No. A418-ND; accepts either MC68HC11A1FN or MC68HC-811E2FN MCU; see text)
U2—27C256 EPROM programmed with BUFFALO 3.4 firmware
U3—74HC373 octal-D tri-state latch
U4—74HC00 quad NAND
U5—6264 8K x 8 static RAM
U6—MAX709LCPA MPU supervisor
U7—MAX232CPE 5-volt dc powered dual RS-232 transmitters and receivers
U8—LM324N quad operational amplifier

Capacitors

C1,C2—27-pF monolithic ceramic
C3,C4—10-µF, 16-volt radial-lead tantalum
C5-C8—22-µF, 25-volt radial-lead electrolytic
CU1 thru CU8—0.1-µF, monolithic ceramic

Resistors (1/4-watt, 5% tolerance)

R1—10 megohms
R2—2,200 ohms
R3—4.7 ohms
R4,R10,R12,R15,R17—4,700 ohms
R5—330 ohms
R6—6,040 ohms, 1% tolerance
R7—7,320 ohms, 1% tolerance
R8—100 ohms
R9, R13—1,000 ohms
R11,R14—100,000 ohms
R16—5,000-ohm miniature pc-mount potentiometer (Digi-Key Cat. No. D4AA53)
RN1—4,700-ohm, nine-element SIP common-terminal resistor network
RN2—10,000-ohm, five-element SIP common-terminal resistor network

Miscellaneous

J1—Four-circuit, 0.1" male header (Digi-Key Cat. No. A1912-ND)
J2—Male printed-circuit DB-9 connector
JP1, JP2, JP3—Two-circuit 0.1" male header (Digi-Key Cat. No. A1911-ND)
JP4—Six-circuit 0.1" male header Cat. No. A1913-ND; use only half of six-circuit header in half)
S1—Spst pc-mount pushbutton switch (Digi-Key Cat. No. P8035S)
XTAL1—4-MHz crystal
Printed-circuit board (see text); IC sockets (see text); power cable with socket that mates with J1 (Digi-Key Cat. No. A3013-ND for housing, A3000-ND for contacts and A3077-ND for keying plug); shorting jumpers; solder; etc.

Note: The following items are available from Magicland, 4380 S. Gordon Ave., Fremont, MI 49412: Complete kit of parts (including double-sided silk-screened pc board with plated-through holes, EPROM with BUFFALO 3.4 firmware, manual with details on construction and documentation, connectors and sockets, but *not* including MC68HC-11A1FN or MC68HC811E2FN), $45; MC-68HC11A1FN, $10 each (maximum of two at this price) when purchased with a complete kit, or $12 each otherwise. A8 10 and EPROM with BUFFALO 3.4 firmware, $12. Add $2.90 for shipping via priority mail. Michigan residents, please add state sales tax. The MC68HC811E2FN 2K EEPROM version is not available at this time from Magicland. You can purchase it for $22 plus $4 S&H from CGN Co., 1000 Chula Vista Terr., Sunnyvale, CA 94086.

Listing 1

```
> ASM 2000
B600  LDS    #FF
B603  LDAA #10
B605  STAA   1000
B608  JSR    B614
B60B  CLRA
B60C  STAA   1000
B60F  JSR    B614
B612  BRA    B603
B614  LDX    #E700
B617  NOP
B618  NOP
B619  NOP
B620  NOP
B621  NOP
B622  NOP
B623  DEX
B624  BNE    B617
B626  RTS
```

to automatically jump to the EEPROM after reset. The primary limitation is the EEPROM's relatively small size: 0.5K for the economical variety of the HC11 version and 2K for the more-expensive HC811. For many controller purposes, 0.5K is sufficient, even though its small size often forces you to write tight code.

Of the several ways to go about designing an EEPROM programmer for the HCx11, the one I chose and described here makes use of the excellent BUFFALO monitor. While BUFFALO Version 3.4 doesn't support direct downloading of .S19 files (a common type of object code) into EEPROM, it's possible to use an indirect method, which I'll describe shortly. This indirect method requires external RAM, which accounts for MAGPRO-11's use of a 6264 8K RAM chip.

Though MAGPRO-11 was originally designed to be a simple programmer, it became obvious that it could easily be turned into an inexpensive HCx11 mini-development system/trainer. The reason for this rests with the BUFFALO monitor's abundant capabilities. Keep in mind that MAGPRO-11 is far from a complete development or training system. While you can test and learn about most of the HCx11's software capabilities, MAGPRO-11 has very limited hardware capability. For those of you who are mainly interested in hardware development, take a look at MAG-11 (also sold by Magicland) or any of the numerous development systems sold by Motorola or one of the HC11 development systems listed in the ads in *MicroComputer Journal*.

All memory addresses given in this article are in hexadecimal. Usually, these addresses are specified with a $ as a prefix (for example, $F800) or with an H as a suffix (such as, F800H). Since the BUFFALO monitor's ASM line assembler doesn't accept any of these conventions, at times neither a $ nor an H is used (such as, F800). Try not to let this confuse you.

About the Circuit

The complete schematic diagram of the MAGPRO-11 circuitry is shown in Fig. 1. The HCx11 MCU with the EEPROM to be programmed plugs into PLCC socket *U1*. This is decidedly different from EPROM programmers that usually use a dedicated MPU or MCU. Here, the intelligence is accomplished by the chip to be programmed! The result is a simple and relatively inexpensive programmer that also functions as a mini-development system.

While HC11s can operate at 2.1 MHz, MAGPRO-11 pushes it to only 1 MHz, since there's little advantage to speed here. The mode for *U1* is set by jumper blocks *JP2*, *JP3* and *JP4*. For normal EEPROM-programmer

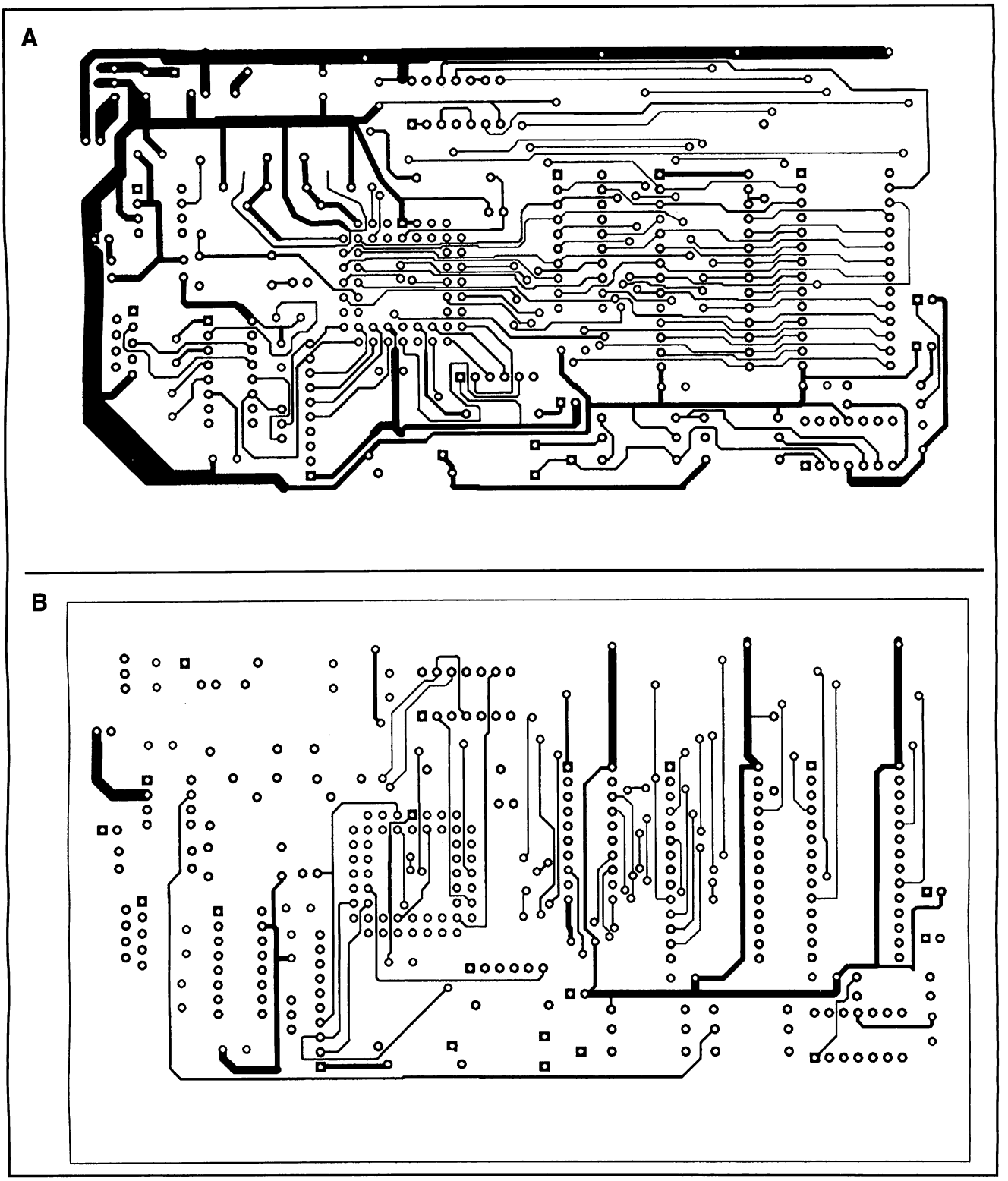

Fig. 2. Actual-size etching-and-drilling guide for MAGPRO11's printed-circuit board. (A) is solder-side view, (B) component-side view.

operation, (normal expanded mode), jumpers at *JP1* and *JP2* aren't used. For normal serial communication with a computer or terminal, a jumper is placed between pins 2 and 3 of *JP4*.

MAX709L MPU supervisory chip *U6* keeps the HCx11 from having problems by pulling the MCU's reset line to ground whenever the +5-volt power line drops below 4.65 volts.

MAX232 *U7* provides driving power for the asynchronous serial interface. MCU-check *LED1* connects to Bit 4 of Port A on the HC11. When this is cleared, *LED1* lights. When it's is set, *LED1* extinguishes. This LED is used to verify that the circuit is performing correctly. It isn't used directly by the BUFFALO monitor, but it has uses if MAGPRO-11 is used for development or educational purposes.

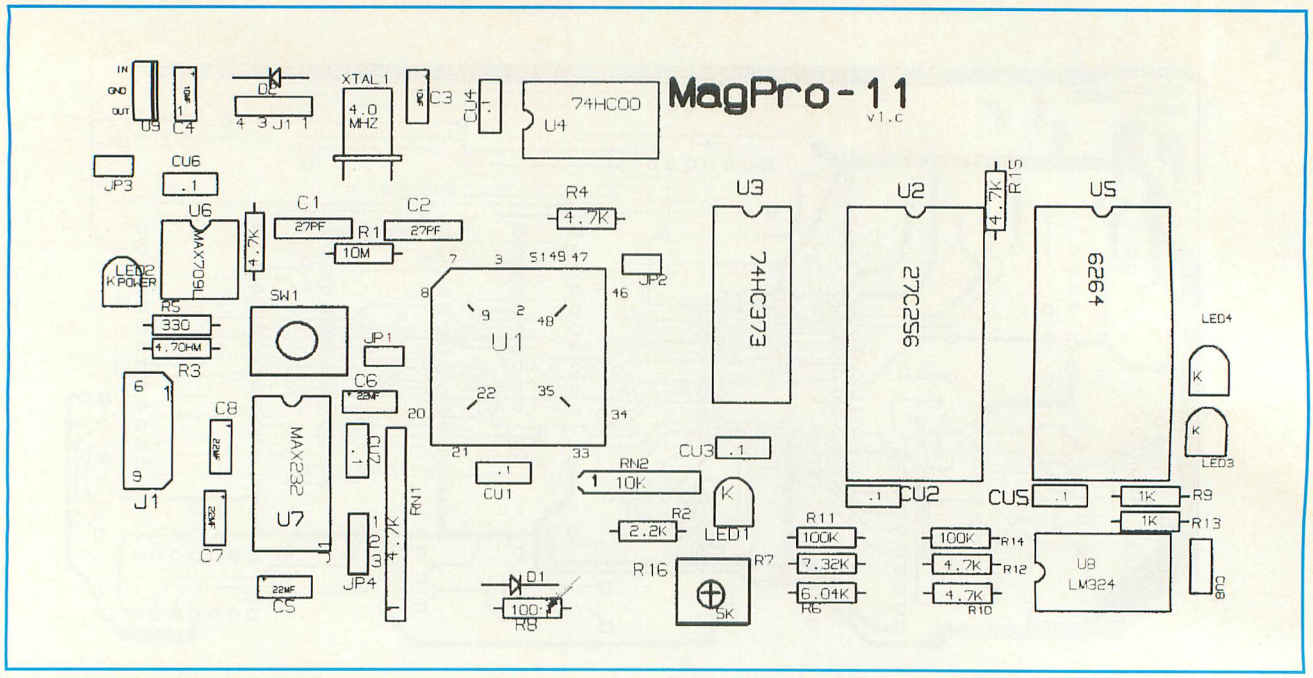

Fig. 3. Wiring guide for pc board.

Since the HC11 has a multiplexed-data/low-order address bus, you must separate the low-order address bus from this multiplexed bus. This task is accomplished with 74HC373 octal D-type transparent latch *U3*. The BUFFALO monitor is contained in 32K 27C256 EPROM *U2*, which responds to hex addresses from 8000H to FFFFH. However, the MCU disables the external address and data buses when addresses between B600H and B7FFH are selected. These addresses are used by the internal 512 byte EEPROM. 8K 6264 RAM *U5* is partially addressed-decoded by *U4A* and *U4B*.

Chip *U5* potentially responds to addresses between 0000H and 1FFFH and between 2000H and 3FFFH. Of course, addresses between 0000H and 00FFH and between 1000H and 103FH are used internally by the HC11. Thus, the external RAM is useless at these addresses. Because of this, it's best to view the RAM as located solely at its redundant memory space between 2000H and 3FFFH. You can use the external RAM's full capability when accessed in this address range.

MAGPRO-11 can be powered by either a regulated 5-volt dc source or an unregulated 8-to-12-volt dc source. As shown in Fig. 1, a jumper is placed at *JP3* only if the source isn't regulated 5 volts dc. If the power source is 5 volts dc, connect the positive voltage source to pin 3 of *J1*. If it isn't regulated, connect the positive source to pin 1 of *J1*. In either case, pin 4 of *J1* must be grounded. When power is applied correctly, green *LED1* lights.

MAGPRO-11 has a unique built-in voltage-monitor circuit consisting of *U8A*, *U8B*, 3.6-volt zener diode *D1*, *LED3* and *LED4*. It also makes use of the voltage-detecting capabilities of *U6*. The over-voltage circuit, which controls red *LED3*, is basically a voltage comparator, with *D1* providing the reference voltage. When the power-supply potential rises above about 5.5 volts, the non-inverting (+) input of *U8A* exceeds 3.6 volts and causes its output to switch high and red *LED3* to light. Potentiometer *R16* compensates for *D1*'s lack of precision.

The low-voltage circuit operates in a slightly different manner. Here, decision-making is basically done by *U6*, whose main purpose is to function as an MPU supervisor. Whenever the supply potential drops below 4.65 volts, RESET pin 7 of *U6* is pulled to near ground potential. In addition to being connected, through a 4,700-ohm resistor to the RESET input of *U1*, pin 7 of *U1* is also connected to the non-inverting (−) input of *U8B*. The + input of *U8B* connects to $^1/_2V_{CC}$. Thus, whenever the potential drops below 4.65 volts, the output of *U8B* goes low, lighting yellow *LED4*, the anode of which connects to +V. This optional voltage-monitor circuit's primary purpose is to provide an inexpensive insurance policy for the HC11.

Construction

Except for the power supply, MAGPRO-11 is a self-contained design. All components mount on a 3" x 6" double-sided printed-circuit board. If you wish to fabricate the pc board, use the actual-size artwork for the solder (A) and component (B) sides shown in Fig. 2. Alternatively, it's possible to wire the circuitry on a single-sided board with the copper traces in Fig. 2(A) and using Fig. 2(B) as a guide for installing wire jumpers in place of the traces shown. If you prefer not to make your own pc board,

(Continued on page 100)

MCU Freeware

Freeware is the name of the Motorola Microcontroller Division's electronic bulletin board. You can obtain the source and .S19 object codes for the BUFFALO monitor from this source, as well as the AS11NEW cross-assembler. Dial the Freeware BBS at 512-891-3733. Set the character format to eight data, no parity and one stop bits.

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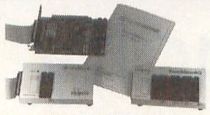
Stock#	1-9	10-24	25+
LSLENS	24.99	23.74	21.37

Eprom Programmer



Programs all EPROMS, EEPROMS, including flash memories. Programs microcontrollers with optional adapters. Complete with software, programming module, cable & manual. Single Device programming.

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ROMMAX	169.99	161.49	145.34

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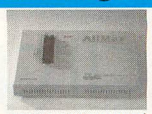
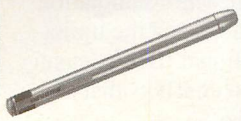


Programs PROM, EPROM, EEPROM, Flash EPROM, serial PROM (8 pin), bipolar PROM, PLD, GAL, PAL, EPLD, PEEL, and mmicrocontroller. Tests logic ICs (TTL/CMOS), and memory (DRAM/SRAM).

Stock#	1-9	10-24	25+
ALLMAX	549.99	522.49	470.24

Laser Pointer



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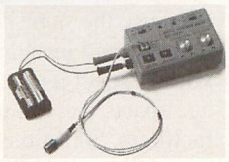

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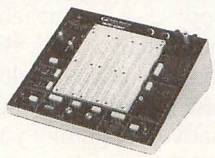

Stock#	1-9	10-24	25+
PB503	259.99	246.99	222.29

Laser Diodes

Stock#	Mfr.	Wavelength	Output	1-9	10-24	25+
LS9520	Toshiba	635nm	3 mW	139.99	132.99	119.69
LS9521	Toshiba	635nm	3 mW	109.99	104.49	94.04
LS9321	Toshiba	660nm	5 mW	49.99	47.49	42.74
LS9200	Toshiba	670nm	3 mW	29.99	28.49	25.64
LS9215	Toshiba	670nm	10 mW	79.99	75.99	68.39
LS9140	Toshiba	685nm	20 mW	169.99	161.49	145.34
LS9150	Toshiba	690 nm	30 mW	269.99	256.49	230.84
LS022	Sharp	780nm	5 mW	17.99	17.09	15.38
SB1053	Phillips	820nm	10 mW	10.99	10.44	9.40

Vacuum Base Vise

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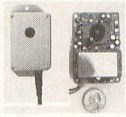

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- .750" L X .400" D

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Large-Capacity Hard Drives

What you need to know about them to make an intelligent buy decision and install them in your PC

With prices falling like hail from a summer storm, it really is difficult to resist buying a new, huge-capacity hard drive. Not many years ago, I paid $1,000 for a 20M hard drive, or about $50 per megabyte. Today, I can walk into a local store and buy a 1.2G hard drive for $425 or about 35 cents per megabyte. By the time you read this, prices will probably be even lower.

So how can you resist hard drives at floppy-disk per-megabyte prices? You probably can't. But you'll be disappointed in the results of such a purchase unless you know a bit about what you're getting yourself into.

You have to ask some questions before you make a buy decision. Can you plug a large-capacity hard drive into your present system? Can you add the new hard drive to the one you already use? Will you get a full 1.2G of storage capacity from the new drive? Will the drive store data efficiently? Can you use all of the drive's storage space with DOS, *Windows* 3.1 or *Windows 95*?

If you're thinking about upgrading your current computer with a gigabyte-sized hard drive, you have consider all of these questions and more. In this article, I hope to pass on to you enough information to make you into a canny buyer. I'll also give you some hints on installing your new purchase in your PC and getting it up on line.

Drive Interfaces

Almost all of the low-priced drives on the market use some variation of the IDE (integrated drive electronics) interface. Higher-priced and sometimes faster drives often use a SCSI interface.

Because IDE drives have provided acceptable, reliable drive performance at a reasonable price, the IDE interface has been standard in IBM/ compatible computers for several years. But if you're upgrading an older computer that has an ESDI, RLL or MFM drive, you'll have to remove the old drive and drive interface card and purchase a new IDE interface card (usually only a few dollars) to install a new large-capacity drive.

Even if you have an IDE drive already installed in your PC, you may not be able to get your old and new drives to work together. In a system with two IDE drives, one must be configured as the "master" and the other as a "slave." Virtually all new drives permit such configuration, usually by means of a small jumper, but some older ones don't. Also, some older drives aren't electronically compatible with today's drives, even if they have a master/slave jumper or setting. The moral is that if you're adding a new drive, be prepared for some possible conflicts.

These "possible conflicts," which can be present in any IDE hard-drive upgrade, are only the first of the problems you'll face. The IDE standard, which was once so simple, has grown to meet the demands of newer and faster hard drives plus new uses, including connecting CD-ROM readers and tape backup units to hard-drive cables. In addition, the hard drive you add to your computer today may vastly exceed the largest drives anyone could imagine when BIOS and DOS hard-drive interfaces were originally written.

The first problem that hard-drive manufacturers have had to face was one of maximum capacity. Large-capacity SCSI drives have been in use for years, especially in network file servers and high-end workstations that must handle vast databases or huge images. DOS has no problem working with large-capacity SCSI drives, although the SCSI driver often must perform translations from DOS's way of viewing a drive to the disk's internal structure.

Large-capacity IDE drives present a different problem. The combination of DOS's limitations and the limitations of the traditional IBM/compatible BIOS leads to conflicts that are difficult to resolve.

One Conflict After Another

The first thing you must realize is that drive manufacturers and DOS don't even use the same counting system. If you buy and install a 500M drive, you'd expect it to have 500M of storage space. According to drive manufacturers, 500M means 500,000,000 bytes. That is, 1M is 1,000,000 bytes. This seems clear enough.

DOS and your BIOS don't see it this way. Internally, computers work with powers of 2. A kilobyte, in DOS and BIOS terms, isn't 1,000 bytes but 2^{10}, or 1,024 bytes. A megabyte is 2^{20} or 1,048,576 bytes. Therefore, if you buy a 500M drive, you're really buying only 476.8M of storage capacity. The rest of the space is used by the partition table, boot record, DOS's root directory and File Allocation Table (FAT). You have about 475M of usable space for your data. Of course, this assumes that you don't lose any space to flaws on the disk's surface itself.

(Manufacturers have found a third way of counting bytes on high-density diskettes. A 720K 3½" floppy diskette has two sides, 80 tracks per side and nine sectors of 512 bytes each per track. Multiplying these figures together, you get 737,280 bytes or 720 "computer" K bytes. A 1.44M diskette has two sides, 80 tracks and 18 sectors of 512 bytes each. Multiplying these numbers together, you get 1,474,560 bytes, which is 1,440K or 1.40625 "computer" megabytes. One megabyte certainly doesn't equal another in the computer world!)

If you buy a 1.2G hard drive, you

should have some idea about the counting system the manufacturer uses to report the drive's size. Think conservatively. A 1.2G drive holds 1,200,000,000 bytes or 1.2G minus overhead for the partition and boot records, root directory and FAT, and any flawed tracks.

DOS's FAT file system adds another limitation to disk usage. Every allocation unit on the disk must be represented by one entry in the File Allocation Table. When you save a file, DOS records the first allocation unit in the directory and then marks this unit as used in the FAT. If the file takes more than one allocation unit, the first entry in the FAT contains a pointer to the second entry, the second to the third entry, and so on.

On most hard disks, each FAT entry is represented by two bytes. Therefore, there can be no more than 2^{16}, or 65,536 allocation units, minus a few for some special FAT codes, on any DOS drive or hard-disk partition. You can't have more files than there are allocation units. OS/2's High Performance File System (HPFS) and *Windows NT*'s New Technology File System (NTFS) both get around this limitation, but DOS and *Windows*, including *Windows 95*, don't.

The FAT system has another handicap besides limiting the number of files you can store because the usable portion of the hard disk is divided into equal-size allocation units or clusters. Cluster size must be a power of 2 times 512 bytes, which is the size of a single sector (see Table 1). On a hard-disk partition that holds less than 128M bytes (computer megabytes, not manufacturer megabytes), a cluster is four sectors, or 2K bytes long. A hard-disk partition with a capacity between 128M and 255M uses clusters of 4K bytes. On a partition between 256M and 511M, a cluster is 8K. On a partition between 512M and 1,023M, a cluster is 16K. Finally, on a partition between 1G and 2G, a cluster is 32K.

DOS assigns one or more clusters to each file and can't share clusters among files. Unless a file happens to be exactly one or more clusters long, some space in the last cluster of each file is wasted. On average, the FAT file system wastes a half cluster per file (if you have a preponderance of short files and small subdirectories, the proportion of waste is greater). If you store 2,000 files on a 1G drive, you'll waste, on average, 1,000 X 32K bytes, or more than 31M!

If you don't like the idea of throwing away a significant percentage of your hard disk's storage space, you can divide it into smaller partitions. You can use the HPFS or NTFS file system or a disk-compression system like Stac Electronics' *Stacker* or DOS's DriveSpace, all of which waste, on average, a half-sector—not a half-cluster—per file.

On the other hand, for convenience sake, you probably want to keep your partitions as large as possible. When you have multiple partitions, you have to search drives C:, D:, E: and F:, for example, for a lost file, instead of just drive C:. You can store files with less wasted or "slack" space on a drive set up with smaller partitions (see Table 2), but most of us can more easily use a drive with a single large partition.

Table 1. Hard-Disk Cluster Sizes & Average Slack Space Per 1,000 "Typical" Files

Partition Size	Cluster Size	Average Slack Space
0 to 127M	2K Bytes	0.98M
128 to 255 M	4K Bytes	1.95M
256 to 511 M	8K Bytes	3.91M
512 to 1,023 M	16K Bytes	7.81M
1G to 2G	32K Bytes	15.63M
2G to 4G	64K Bytes	31.25M

DOS and the BIOS

The traditional IBM/compatible BIOS is capable of working with hard drives with capacities up to 8G (8.5-billion bytes). Theoretically, DOS can work with even larger-capacity drives. But when you put together DOS and the traditional BIOS, maximum hard-disk size suddenly shrinks to 528M because of the way DOS and the BIOS communicate with each other.

Until recently, this wasn't a real limitation, since only SCSI hard drives were larger in capacity than the DOS/BIOS limitation. Since SCSI drives don't use the computer's built-in BIOS for drive access at all, they weren't affected by the DOS/BIOS limits. But with the new large-capacity IDE drives, the DOS/BIOS limitation is a real issue. To understand how to circumvent this limitation (which affects large-capacity drives whether or not you break them into smaller logical partitions), you first need to understand what causes it.

The BIOS sees an IDE drive as a simple, old-fashioned Western Digital drive and sends signals to the drive accordingly. It's up to the drive and the electronics on the drive's built-in controller to translate these signals into meaningful commands that apply to the hard drive itself. The IDE standard was originally implemented for hard cards—20M to 40M hard drives on a card that fit into a computer via an expansion slot on the motherboard. For this reason, IDE drives are sometimes called ATA, or AT-Attachment, drives.

Three pressures have forced the industry to upgrade the ATA or IDE standard. First, larger-capacity hard drives require a new set of signals. Second, hard drives are potentially faster than the AT or ISA (industry standard architecture) bus. Third, other devices like CD-ROM readers and tape backup units have recently appeared that can also be connected to an IDE adapter, but doing so requires several changes in both the adapter

Counting Bytes

	DOS & BIOS	Hard Disk	Floppy Diskettes
1 Kilobyte	1,024 Bytes (2^{10})		1,024 Bytes (2^{10} Bytes or Two Sectors)
1 Megabyte	1,048,576 (1,0242 or 2^{20})	1,000,000 (10^6)	1,024,000 (1,00 x 1,024 or 1,000K or 500 Sectors)
1 Gigabyte	1,073,741,824 (1,0243 or 2^{30})	1,000,000,000 (10^9)	

and the software (the BIOS) that runs the adapter.

Taken together, these pressures have been responsible for a number of changes. First, a new set of hardware standards has appeared, called enhanced IDE for the interface and Fast ATA or ATA-2 for drives. Unfortunately, there isn't yet an accepted way to abbreviate "Enhanced IDE." You may see e-IDE, E-IDE, EIDE, IDE-E, etc. All of these abbreviations mean the same thing. I prefer the abbreviation EIDE.

Potentially, an EIDE interface can overcome all of the limitations built into the older IDE interface. First, it can handle drives up to 8G in capacity (8.5-billion bytes). Second, Fast ATA or ATA-2 drives, which are often larger in capacity than 528M, can transfer data at up to 13M bits per second, as opposed to the 3M/s to 5M/s that's common with standard IDE/ATA drives. Third, an EIDE interface can handle up to four devices (hard drives, CD-ROM readers, etc.), which is an improvement over the limit of two devices supported by a the traditional IDE interface card.

If you purchase a Fast ATA or ATA-2 drive, you don't necessarily have to connect it to an EIDE interface card. You can connect the drive to a traditional IDE interface, as long as you're willing to accept two consequences. One is that the drive can't transfer data any faster than your computer's ISA bus, which means that data transfers will generally be limited to the 3M/s to 5 M/s range the AT bus supports. To reach the full data-transfer potential of the drive, you must connect it to an EIDE interface card that's hooked into a local bus or PCI bus in your computer.

The other consequence is that, unless you install special software that overcomes the limitations of the DOS/BIOS disk interface, you won't be able to use more than 528M of the drive. Fortunately, almost all large-capacity drives are supplied with such software.

All you need to do is buy an EIDE controller when you purchase the new hard drive, right? Well, not really. An EIDE controller will work only with the appropriate BIOS or driver software. If you want a "pure" solution, you can buy an EIDE controller and a new upgraded BIOS chip (if one is available for your computer). But an EIDE controller, all by itself, won't do you much good.

Advancing Standards

IDE, EIDE, ATA, Fast ATA and ATA-2 aren't enough. The EIDE standard recognizes larger-capacity hard disks and four devices (when coupled with the proper BIOS software). Why not make one or two of these devices CD-ROM readers or high-capacity tape backup units and forget the SCSI or proprietary interfaces that these devices often require? This sounds fine in theory, but it presents a few snags in practice. It's possible to connect an EIDE or Fast ATA drive to a "classic" IDE interface and have the drive simply work slower than it otherwise would. But it's not usually possible to connect a CD-ROM reader or high-capacity tape drive to a classic IDE interface.

CD-ROM isn't simply a slow read-only drive. A CD-ROM reader is also responsible for playing audio information (from both CD-ROM and audio CDs). Running a wire from the CD-ROM reader to speakers or a sound card isn't difficult, but communicating with the reader via an IDE interface is more than a little tricky.

On a traditional IDE interface, a CD-ROM drive presents two problems. To begin with, it's much, much slower than a hard drive. According to user reports, it appears possible to get data from the CD-ROM mixed up with data going to the hard drive on the same interface. The result is garbled data on your hard drive.

Even if data aren't corrupted (and they won't be on a properly installed EIDE system), the slow speed of the CD-ROM drive can stall hard-drive reads and writes. For example, if you're working in *Windows*, reading from a CD-ROM at the same time as *Windows* is trying to access its swap file on your hard disk, you'll experience a noticeable system slow-down and perhaps even a complete lock-up if *Windows* needs to save data to the hard drive before it can load the block of data from the CD-ROM into an application's memory area.

One way to circumvent the speed conflict is to install two EIDE controllers in your PC, one on a PCI- or local-bus slot for hard drives and a second on the computer's ISA bus for slow devices like CD-ROM and tape drives. Of course, adding a second EIDE controller will work only if the CD-ROM and tape driver software supports secondary controllers at non-standard addresses.

Another problem is that CD-ROM readers require more instructions than a hard drive. The IDE interface is set up to send the required commands to a hard drive in the CPU's registers. Instead, a CD-ROM reader needs a packet of commands. This requires an AT Attachment Packet Interface (ATAPI) that sends packets of data to devices on the EIDE controller. ATAPI must be implemented in your BIOS or in special driver software loaded (usually) by your CONFIG.SYS file.

Even ATAPI isn't a final solution. There's no guarantee that a CD-ROM drive, large-capacity hard drive and tape backup unit connected to an EIDE controller will be compatible with each other. Each device will have its own driver, and each driver will probably demand complete control of the EIDE controller while its device is operating to be able to issue the packets of instructions. Also, since there's no standard way of issuing packet commands to devices on an EIDE controller, *Windows* 32-bit drive access, which is even more important in *Windows 95* than in *Windows* 3.1, may or may not work with the CD-ROM drive, large-capacity hard drive and other devices on an EIDE controller.

The emerging solution is another new standard, called the AT Attachment Software Programming Interface (ATASPI). ATAPSI is generally implemented as a load-able device driver that gives programs and operating systems a standard method of interacting with IDE devices. In turn, the ATAPSI software handles the messy hardware-level details of any particular EIDE adapter and the devices connected to it.

Installing a New Drive

EIDE, ATAPI and ATAPSI may all be in your future, but they may not be much help if you simply want to add a new large-capacity hard drive to your computer. Here are some tips that should help, but remember that standards are in flux right now, and you may have to take a different approach,

depending on the demands of your system.

I'll start by assuming you have an IDE controller with a single hard drive attached to it and that the IDE controller is attached to the AT bus on your computer, either in a slot or wired into your motherboard. I'll also assume that you don't want to (or can't) add an EIDE controller and its attendant software or BIOS upgrade to your computer and that you have no plans at the present time to add an IDE-based CD-ROM drive, tape backup drive or other accessory (a tape backup unit connected to the floppy-drive system isn't the same as one connected to an IDE controller).

When you buy your new hard drive, the first thing to check is whether or not support is available to help get it running and whether or not you can return it if it proves to be incompatible with your system. Of course, you want the same assurances for any accessory you add to your system, although a surprising number of purchasers don't ask about either.

If you want the new drive to co-exist with an old drive instead of replace it, you also need to know how to set the master/slave jumper or switch on each (see Fig. 1). The settings are usually clearly documented on newer drives and sometimes obscure or missing completely on older drives. You might want to check your current drive and its documentation before you start shopping for a new drive.

If you're lured by the reported high data speeds of the new high-capacity drives, beware. High speeds in the 11M/s to 13M/s range are usually attainable with only an EIDE interface on a local or PCI bus. If you connect the drive to a traditional IDE controller on an AT bus, look for data-transfer speeds in the range of 3M/s to 5M/s, no matter how fast the rated speed of the drive.

Unless your computer already has an EIDE interface and BIOS support for it, you need software to access the drive. Most large-capacity drives are shipped with the required software, either on a diskette or installed on the drive itself. Most such software is fairly flexible and will let you install your new drive as either Drive 0 or Drive 1 (the first or second hard drive on the IDE controller) and will let you partition the drive as you see fit. However,

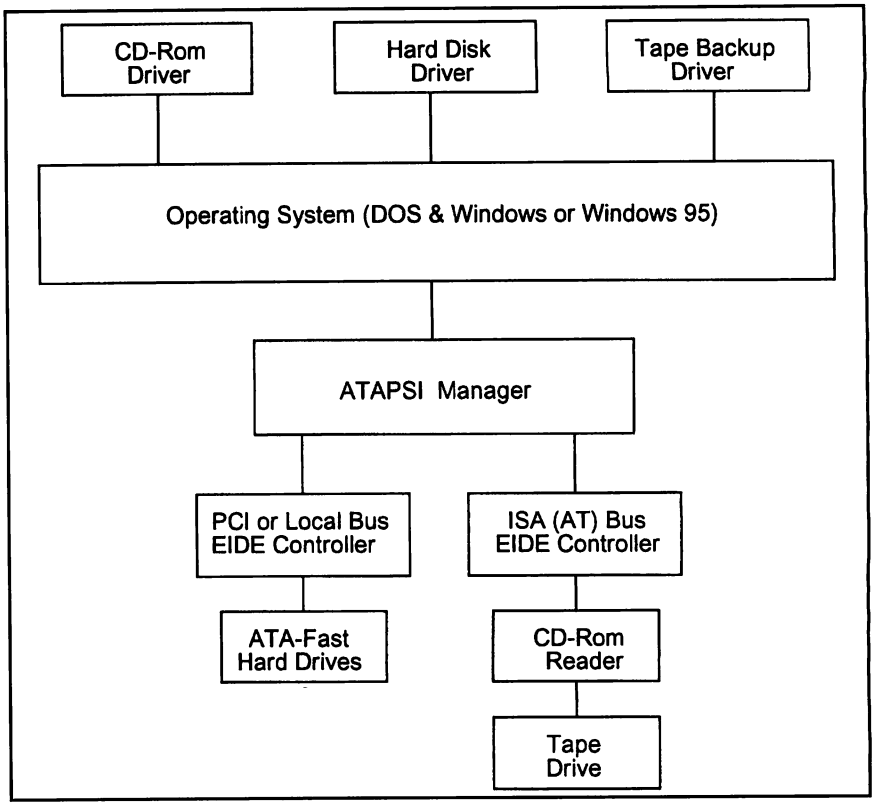


Fig. 1. Ideal setup for multiple IDE drives and devices.

some software insists that you install the drive as Drive 0 or even as the only drive. Some even limit the ways in which you can partition the drive. Find out as much about the software as you can before you buy a new drive.

Will the software support other operating systems (OS/2, *Windows NT*, Linux, etc.) that you may want to install on your computer, or are you content to stay with DOS and *Windows* or *Windows 95*? Is the software compatible with *Windows 95* or just DOS 6 and *Windows* 3.x? Can you use 32-bit disk access from *Windows*, *Windows for Workgroups* and *Windows 95*? If you can't get satisfactory answers to these questions, the hard drive may not be worth purchasing at all. "New drivers will be available soon" may mean that the company will start developing a driver if and when it thinks there's enough consumer interest.

If you're going to partition your drive to save on wasted slack space, and if the necessary driver comes installed on the hard disk, make sure you save it on a floppy diskette before you run FDISK or a similar utility. Partitioning a hard disk usually destroys all of the data on it, although sometimes some of the data in the first partition can be recovered. If you destroy the only copy of the software you have, you're going to feel both angry and foolish when you call technical support for another copy and then wait for it to arrive.

Finally, I never load any data onto a new hard drive until I run a surface analyzer over the entire drive. My two favorites are the *Norton* Disk Doctor (part of Symantec's *Norton Utilities*) and *SpinRite* from Gibson Research. Even though a full test of a large-capacity hard disk by either program will take many hours, I don't think it makes sense to trust any data to a hard disk I haven't thoroughly tested. Also, the test run will help confirm that the drive has been properly installed.

Installing a modern, very-large-capacity hard-disk drive on a traditional computer is something like putting vastly oversized tires on a pickup truck. It can be done, but it takes some planning and expertise. The low prices of the new high-capacity hard drives make them very attractive, indeed. If you're aware of the problems these drives might present and plan for them, you should be able to install one of the new drives on your computer quickly and easily. ■

By Jonathan Michaels

Interrupt Processing on the PIC 16C71

Microchip's support for interrupts on its new series of PIC controllers is good news—but you'll have to learn how to deal with these chips, though the process is fairly easy

One of the most prevalent comments about the PIC series of microcontrollers has been that no support exists for interrupts. This is no longer so, thanks to Microchip, which now has new members of the PIC family that support interrupt processing. One of these, the 16C71, is one of the first members of the PIC family to support interrupts. Since this is all new, knowledge about interrupt processing on a PIC isn't as commonplace as is interrupt processing on other processors that have long offered support for it.

There's good news and bad news here. The bad news is that you have to learn to deal with the way another chip handles interrupts. The good news is that PIC interrupts aren't difficult to work with, once you figure them out. In this article, I'll discuss some methods you can use for interrupt processing on the PIC 'C71. You should be able to use this information as the basis for any of your PIC projects in which you plan to perform interrupt processing. After reading this article, you should be able to leverage off what I present when you implement your own interrupt-savvy PIC software.

PIC Interrupt Puzzle

The PIC is a fairly uncomplicated device, which makes understanding how to handle interrupts on it a pretty easy thing to do. Unfortunately, the

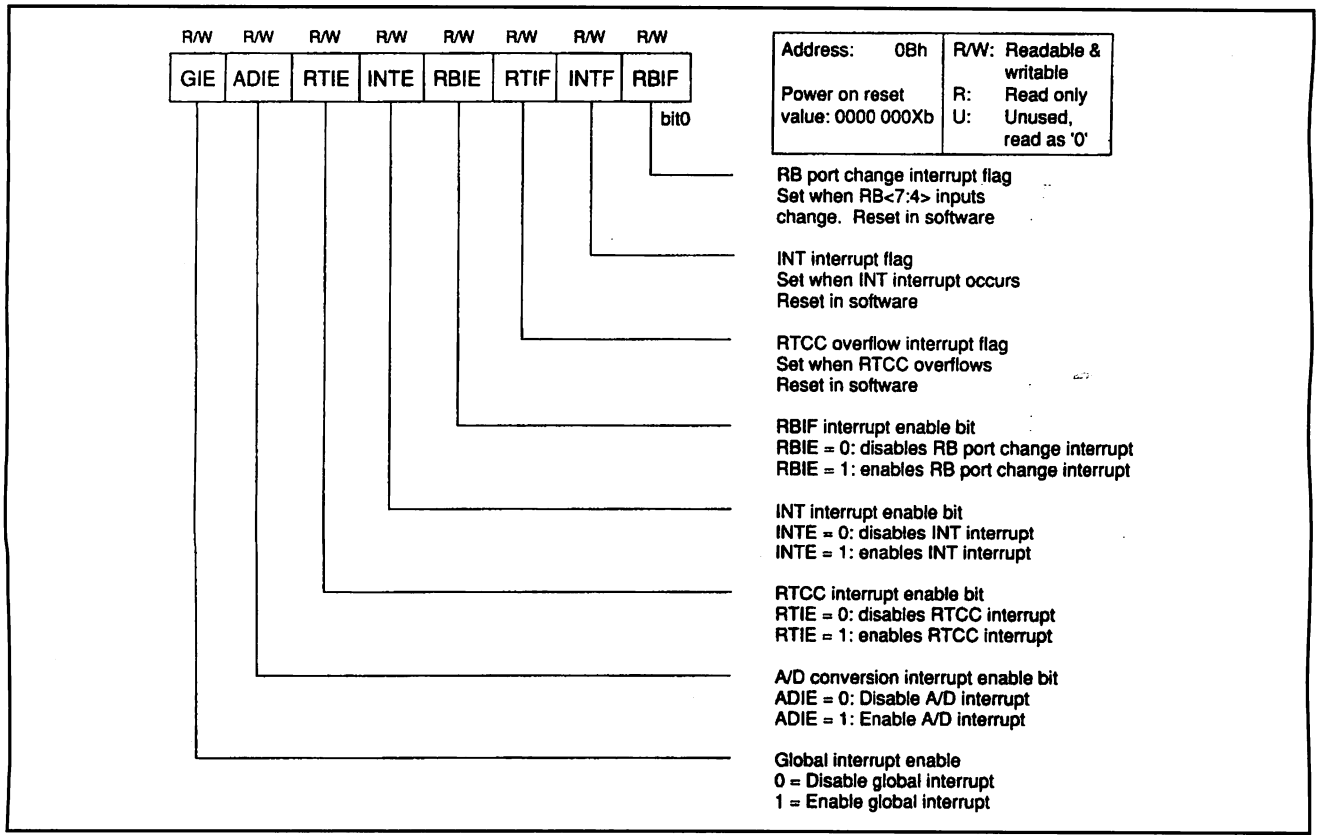


Fig. 1. How bits are assigned in the INTCON register.

way PIC documentation is organized, you have to hunt hard to pick up all the pieces of the how-to-handle-interrupts puzzle. This is because the relevant facts are scattered about here and there in the data book. Needless page flipping is the greatest hurdle you'll have to overcome in learning to code for interrupts on the PIC. I hope to put all required information in one place with a few code examples (woefully omitted from the Microchip documentation) so that you can enjoy an easier learning experience than I had.

The key to interrupt processing on the PIC is the INTCON register, which is Grand Central Station as far as PIC interrupts are concerned. This register contains bits that must be set to enable any specific interrupts on the device. It also contains several bits that serve as flags to communicate with your application program that caused the interrupt. An illustration of how these bits are assigned in the INTCON register is shown in Fig. 1. In some cases, other registers are involved in interrupt processing. I'll illustrate these specific cases later. But for the most part, since interrupt processing is still highly dependent on the INTCON register, I'll start here.

To enable interrupts on the device, the GIE (Global Interrupt Enable) Bit 7 of the register must be set. In addition, you must set additional bits in the INTCON register to enable any of the specific interrupt sources that are available on the chip. The PIC supports four interrupt sources. Two are external interrupts and the remainder are internal interrupts. Therefore, you must set the appropriate bits in the INTCON register to enable any particular one of them. Figure 2 shows a logical description of how the settings of the interrupt-enable bits in the INTCON register affect the overall ability of the chip to receive interrupts.

Setting any particular interrupt-enable bit can be easily accomplished with the BSF assembly-language instruction. Likewise, disabling any interrupt can be done by applying the BCF instruction to the bit. Another operation you'd probably want to do when you initialize your program is to move a literal (constant) value to the W register with the MOVLW instruction and then move this value to the INTCON register with the MOVWF instruction. In the latter case, the literal value should be designed to enable the specific interrupts your code will need to track and disable any interrupts with which you don't want to deal. Listing 1 provides an example of both methods.

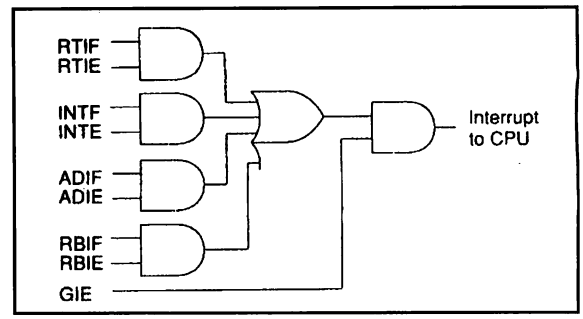


Fig. 2. Logical description of how the settings of the interrupt-enable bits in the INTCON register affect the overall ability of the chip to receive interrupts.

It's important to note that when the PIC 'C71 powers up, the interrupt-enable bits are cleared. Hence, the chip won't respond to any interrupt stimulus, requiring you to set up this register if you're going to perform interrupt processing on this device. This is probably a good thing because you don't want the processor to jump into an interrupt code until you've finished setting up the chip and your program's variables. At this point, you can enable the interrupts you want and continue on your way.

Listing 1*

```
; ************************** CONSTANTS
INTCON    equ     0bh     ; address of INTCON register
; ************************** INTCON register
GIE       equ     .7      ; Global Interrupt Enable
ADIE      equ     .6      ; ADC Interrupt Enable
RTIE      equ     .5      ; RTC Interrupt Enable
INTE      equ     .4      ; External Interrupt (Port B, Bit 0)
RBIE      equ     .3      ; Delta Level Interrupt (Port B, Bits 4-7)
RTIF      equ     .2      ; RTCC Interrupt flag
INTF      equ     .1      ; External Interrupt flag
RBIF      equ     .0      ; Delta Level Interrupt (Port B, Bits 4-7)
;************************************************
; An example of how to set an initial value for the INTCON
; register. This value enables interrupts and also enables the
; interrupt on deltas on Port B at bits 4 through 7
;************************************************
IntBootVal  equ     .136    ; bit 7=1, bit 3=1, bits 4 to 6=0
; ************************** Set up INTCON register
YourInitCode    movlw   IntBootVal      ; shows how to set up multiple
                movwf   INTCON          ; values in the INTCON register
YourMainCode    bsf     INTCON,RBIE     ; enables this interrupt
                bcf     INTCON,RBIE     ; disables this interrupt
```

* Two methods for manipulating the INTCON register. One method uses the bit operations included in the PIC Assembly language. The other method is recommended for initialization or for any other time when you want to change the overall settings of the chip's response to interrupts.

Listing 2*

```
; ************* Chip starts execution at here
Start           org     0               ; boot up address
                goto    BootCode        ; branch to your main entry point
; ************* Interrupts vector to here
IntVector       org     4               ; do interrupt stuff in here
                retfie
EndIntVector
; ************* Main entry point in the program
BootCode                                ; do your initialization here
```

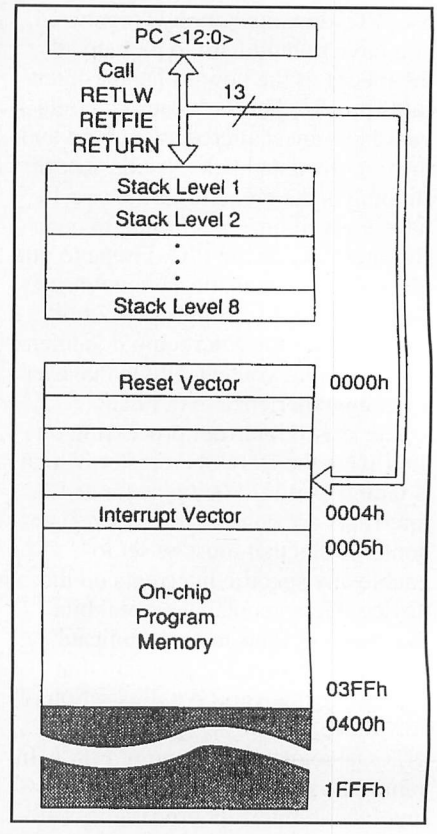
*Since the PIC 'C71 vectors to 004h, you must park the entry point of your interrupt handler at that address. To complicate matters, the chip begins executing at 000h when it powers up. So you must invoke a little assembly-language wizardry to stitch it all together.

Listing 3*

```
; ***************************** CONSTANTS
Port_A      equ     .5          ; Port_A address
Port_B      equ     .6          ; Port_B address
INTCON      equ     0bh         ; define address of INTCON register

; ***************************** INTCON register
GIE         equ     .7          ; Global Interrupt Enable
ADIE        equ     .6          ; ADC Interrupt Enable
RTIE        equ     .5          ; RTC Interrupt Enable
INTE        equ     .4          ; External Interrupt (Port B, Bit 0)
RBIE        equ     .3          ; Delta Level Interrupt (Port B, Bits 4-7)
RTIF        equ     .2          ; RTCC Interrupt flag
INTF        equ     .1          ; External Interrupt flag
RBIF        equ     .0          ; Delta Level Interrupt (Port B, Bits 4-7)
;************************************************
; An example of how to set an initial value for the INTCON
; register. This value enables interrupts and also enables the
; interrupt on deltas on Port B at bits 4 through 7
;************************************************
IntBootVal  equ     .136        ; bit 7=1, bit 3=1, bits 4 to 6=0
DDRPortA    equ     ???         ; application dependent
DDRPortB    equ     ???         ; application dependent
; ***************************** Chip starts execution at here
Start       org     0           ; boot up address
            goto    InitCode    ; branch to your main entry point
; ***************************** Interrupts vector to here
IntVector   org     4           ; do interrupt stuff in here
EndIntVector
; ***************************** Main entry point in the program
InitCode
;************************************************
; Setting up the INTCON register with your boot value.
; For more reliable operation of the chip, you should perform
; all other initialization before enabling interrupts
;************************************************
            movlw   DDRPortA    ; Port A direction control
            tris    Port_A
            movlw   DDRPortB    ; Port B direction control
            tris    Port_B
            movlw   OptionVal
            option              ; set up the option register
            movlw   IntBootVal
            movwf   INTCON      ; enable interrupts
EndInitCode
MainCode    bcf     INTCON,GIE  ; enter critical section
                                ; critical processing
            bsf     INTCON,RBIE ; exit critical section
```

*Summary of the ideas presented thus far. This listing begins to build a framework you can use for general design of PIC 'C71-interrupt-aware programs. This code sample uses the TRIS and OPTION instructions. Later samples will show how to directly manipulate these register values. The reason for this is that Microchip has made the OPTION and TRIS registers addressable and is discouraging use of the OPTION and the TRIS instructions in all new development projects that use PIC processors.



Boot-up and interrupt-vector addresses and information about the stack in relation to the interrupt vector and instructions that affect the stack.

Once you set up the INTCON register, the chip can accept stimulus from any and all of the enabled sources. When the chip responds to an interrupt, it's hard-coded to vector to 004h in the program space. This is where your interrupt code's entry point must reside. Since the device begins execution at 000h, this requires a little sleight of hand so that these two entry points don't "walk" on each other. A solution to handling this situation is shown in Listing 2.

As you can see by the example in Listing 2, you have to jump around the interrupt's entry point. This particular implementation wastes three words of the program space (addresses between the GOTO BootCode and the ORG 4 statements). It's possible that you could place a couple of other instructions here as long as you don't accidentally produce a situation in which you overlay code at address 004h because the assembler won't be able to resolve this situation. Unless you're really pushing the limits on filling up the 1K words of program space in the PIC 'C71, I wouldn't bother.

A summary of everything that has been covered up to this point is given in Listing 3. The main points to glean from Listing 3 are the organization of the program to accommodate the way the device operates. In addition, it incorporates the ideas covered in Listing 1.

You might have guessed that what I'm building up to is a framework that can be used as a general method for working with the PIC 'C71. If so, forgive any redundancy that may appear in the sample code as I am trying to take a step-by-step approach at a pace that should be comfortable for anyone who is new to this device.

Some readers will notice the definition of a critical section in the MainCode section at the end of Listing 3. When GIE Bit 7 of the INTCON register is cleared, all interrupts are disabled. This prevents the program from vectoring to the interrupt handler, regardless of what kind of

PIC 16C71 Register File Summary

Filename		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on Power-On Reset
Page 0:										
00	INTO	Uses Contents of FSR to Address Data Memory (Not a Physical Register)								00000000
01	RTCC	Eight-Bit Real-Time Clock Counter								XXXXXXXX
02	PCL	Low-Order Eight Bits of PC								00000000
03	STATUS	IRP	RP1	RP0	TO	PD	Z	DC	C	00011XXX
04	FSR	Indirect Data Memory, Address Pointer 0								XXXXXXXX
05	PORTA	-	-	-	RA4/ RT	RA3/ AIN3/ V_{REF}	RA2/ AIN2	RA1/AIN1	RA0/ AIN0	XXXXXXXX
06	PORTB	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0/ INT	XXXXXXXX
07		Not Implemented								
08	ADCONO	ADCS1	ADCSO	-	CHS1	CHS0	GO/ DONE	ADIF	ADON	00000000
09	ADRES	Eight-Bit A/D Result Register								XXXXXXXX
0A	PCLATH	Holding Register of High Byte of PC								---00000
0B	INTCON	GIE	ADIE	RTIE	INTE	RBIE	RTIF	INTF	RBIF	0000000X
Page 1:										
80	IND0	Mapped in Page 0								
81	OPTION	-RSPUB	INTEDG	RTS	RTE	PSA	PS2	PS1	PS0	11111111
82	PCL	Mapped in Page 0								
83	STATUS	Mapped in Page 0								
84	FSR	Mapped in Page 0								
85	TRISA	PORTA (105) Data Direction Register								---11111
86	TRISB	PORTB (106) Data Direction Register								11111111
87		Not Implemented								
88	ADCON1	-	-	-	-	-	-	PCFG1	PCFG0	------00
89	ADRES	Mapped in Page 0								
8A	PCLATH	Mapped in Page 0								
8B	INTCON	Mapped in Page 0								

interrupt stimulus is received by the chip. Having the ability to define a critical section of code is an important tool of any program that works with interrupts, and seeing how simply a critical section can be defined in the PIC 'C71 is encouraging.

Did You Register That?

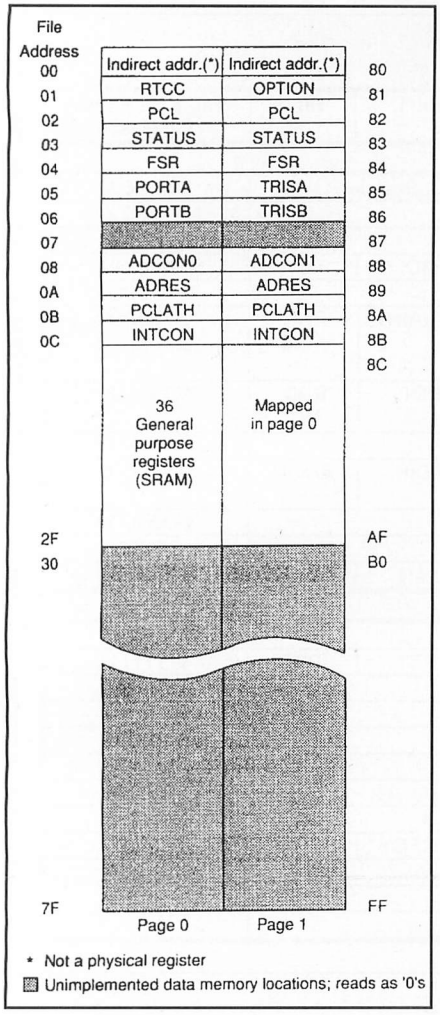
Before I proceed, I should explain a little more about the individual who caused the interrupt flags in the INTCON register so that later, when I discuss decoding an interrupt, the context will be understood.

The INTF interrupt is one of two available external interrupts on the PIC 'C71. The INTF bit is set when the processor has seen an edge on the Bit 0 line of Port B. This interrupt can be further configured to respond when a rising or falling edge is encountered. The direction of the edge that will cause the trigger is set by INTEDG Bit 6 in the OPTION register. If the INTEDG bit is set, the INTF interrupt will

Listing 4*

```
; ***************************** Define Register Addresses
INTCON    equ     0bh       ; Interrupt Control Register
OPTION    equ     01h       ; On Chip Option Register
STATUS    equ     03h       ; On Chip Status Register
TRISB     equ     06h       ; On Chip DDR register
; ***************************** Define Register Bits
GIE       equ     .7        ; Global Interrupt Enable
INTE      equ     .4        ; External Interrupt Enable
PAGE      equ     .5        ; Register Page Selection Bit
INTEDG    equ     .6        ; Edge Selector Bit
BIT0      equ     .0        ; Bit 0 on a Port or Register
;************************************************
; How to set up the INTF interrupt on the PIC 'C71. Interrupt
; control pin (Port B, Bit 0)is connected to external signal source
;************************************************
InitCode  bsf     STATUS,PAGE       ; set to register page 1
          bsf     TRISB,BIT0        ; set Bit 0 on Port B as input
          bsf     OPTION,INTEDG     ; sets interrupts on rising edge
          bcf     STATUS,PAGE       ; set to register page 0
          bsf     INTCON,RTIE       ; enables external interrupts
          bsf     INTCON,GIE        ; enables interrupts
```

*This short code snippet illustrates the basic operations required to set up the PIC 'C71 processor to trigger on edges on the Port B Bit 0 input line. Note the lack of use of TRIS and OPTION statements. Instead, these registers are directly manipulated per recommendations from Microchip regarding writing code for these registers that's more likely to be upward-compatible with future generations of chips from this family. Microchip is discouraging use of the TRIS and OPTION statements in its newer processors.



Addressable locations for all of the PIC's internal addressable registers.

be triggered when a rising edge is seen at Bit 0 on Port B. If the INTEDG bit is cleared, the INTF interrupt will be triggered on a falling edge on this same pin. To enable this interrupt, the INTE and the GIE bits in the INTCON register must both be set, and the Port B, Bit 0 line must be set up as an input pin. This interrupt can be used to wake up the PIC 'C71 from sleep state if the INTE bit is set before the processor is placed in sleep state. If GIE is also set when the processor is

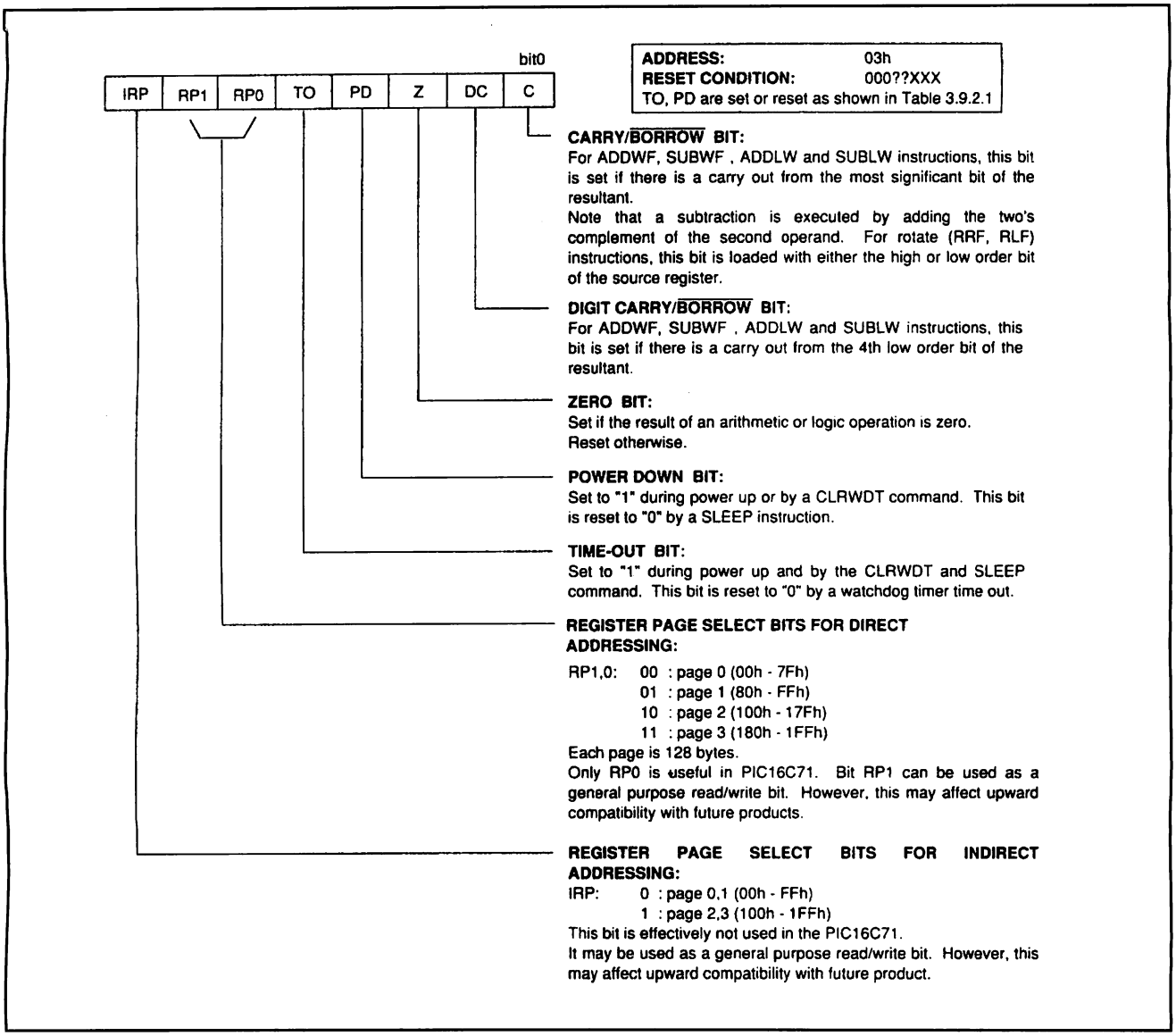
Listing 5*

```
; ***************************** Define Register Addresses
INTCON      equ     0bh     ; Interrupt Control Register
OPTION      equ     01h     ; On Chip Option Register
STATUS      equ     03h     ; On Chip Status Register
RTCCREG     equ     01h     ; RTCC register
; ***************************** Define Register Bits
GIE         equ     .7      ; Global Interrupt Enable
RTIE        equ     .5      ; Real Time Clock Interrupt Enable
PAGE        equ     .5      ; Register Page Selector
PSA         equ     .3      ; Prescaler Assignment Bit
RTS         equ     .5      ; RTCC Clock Source Selector Bit
;************************************************
; How to set up the RTIF interrupt on the PIC 'C71.
; This first section shows how to reassign the prescaler from
; the RTCC to the WDT. Note that interrupt disabling will
; be required if they were previously enabled.
;************************************************
        bcf     INTCON,GIE      ; disable interrupts
        bcf     INTCON,RTIE     ; disable RTIF
        bsf     STATUS,PAGE     ; set to register page 1
        bcf     OPTION,PSA      ; assigns prescaler to RTCC
        bcf     OPTION,RTS      ; RTCC internally clocked
                                ; see PIC 'C71 data sheet section 6.4.2 for more
information on
                                ; Prescaler information.
        bcf     STATUS,PAGE     ; set to register page 0
        clrf    RTCCREG         ; clears RTCC and Prescaler
        bsf     STATUS,PAGE     ; set to register page 1
        bsf     OPTION,PSA      ; assigns prescaler to WDT
        bcf     STATUS,PAGE     ; set to register page 0
        clrwdt                  ; clears WDT and Prescaler
                                ; see PIC 'C71 data sheet figure 6.5.1 for select-
ing prescaler divisor
;************************************************
; Reassign Prescaler from WDT to RTCC
;************************************************
        clrwdt                  ; clears WDT and Prescaler
        bsf     STATUS,PAGE     ; set to register page 1
        bcf     OPTION,PSA      ; assign Prescaler to RTCC
                                ; see PIC 'C71 data sheet figure 6.5.1 for select-
ing prescaler divisor
                                ; since you would set that value here before you
do the following
                                ; instruction.
                                ; pick only one of the following two instructions
        bsf     OPTION,RTS      ; selects external clock
        bcf     OPTION,RTS      ; selects internal clock
                                ;
        bcf     STATUS,PAGE     ; set to register page 0
        movlw   LoadTimerVal    ; you define this value
        movwf   RTCCREG         ; move the value to the RTCC
        bsf     INTCON,RTIE     ; enable RTCC interrupt
        bsf     INTCON,GIE      ; enable interrupts
```

*It seems like nearly every on-chip control register is involved in setting up the RTIF interrupt. Its setup is complicated by multiple clock sourcing options and the fact that it shares an on-chip resource (prescaler) with the on-chip WDT peripheral. I strongly recommend that you carefully review the PIC databook if you're planning to share the prescaler between the WDT and the RTCC. Note the lack of use of the OPTION instruction.

PortA Functions

Port Pin	Bit	Pin Function	Alternate Function
RA0/AIN0	Bit 0	Input/Output Port. TTL Input Levels	Analog Input Channel 0
RA1/AIN1	Bit 1	Input/Output Port. TTL Input Levels	Analog Input Channel 1
RA2/AIN2	Bit 2	Input/Output Port. TTL Input Levels	Analog Input Channel 2
RA3/AIN3/V_{REF}	Bit 3	Input/Output Port. TTL Input Levels	Analog Input Channel 3 or External Reference Voltage (V_{REF}) Input
RA4/RT	Bit 4	Input/Output Port. Output is Open-Collector; Input is Schmitt-Trigger.	External Clock Input for RTCC Timer/Counter



Addresses of all the addressable registers in the PIC 16C71 device.

put to sleep, the processor will branch to the interrupt vector when it's awakened by an appropriate edge occurring on the Port B, Bit 0 line. See Listing 4 for examples that illustrate some of these ideas.

The RTIF interrupt occurs when the RTCC timer/counter overflows from FF to 0. Since RTCC is involved in this interrupt, its setup complicates the setup of this interrupt. The RTCC subsystem is the most-complex aspect of this operation because it can be internally or externally clocked and can be assigned the prescaler. I'll try to cover a few samples of how to set up this interrupt. However, since it can also involve the WDT on the PIC '71, it can become quite involved. It's probably best to cover the entire topic in code samples, rather than try to verbalize it. (See Listing 5 for more coverage on how to deal with setting up this interrupt.)

After the previous two examples, the method for setting up the RBIF interrupt is going to seem like a cake

Summary of PortA Registers

Register Name	Function	Address	Power-On Reset Value*
PORTA	PortA Pins When Read; PortA Latch When Written	05h	---X XXXX
TRISA	PortA Data Direction Register	85h	---1 1111
ADCON1	A/D Converter Control Register	88H	---- --00

* - = unimplemented (reads as a 0); X = unknown

PortB Functions

Port Pin	Bit	Pin Function	Alternate Function
RB0/INT	Bit 0	Input/Output Port. TTL Input Levels & Internal Software Programmable Weak Pull-Up	External Interrupt Input
RB1	Bit 1	Same as Above	-
RB2	Bit 2	Same as Above	-
RB3	Bit 3	Same as Above	-
RB4	Bit 4	Same as Above	Interrupt on Port Change
RB5	Bit 5	Same as Above	Same as Above
RB6	Bit 6	Same as Above	Same as Above
RB7	Bit 7	Same as Above	Same as Above

walk. The RBIF is the second external interrupt available on the PIC 'C71. This interrupt is triggered whenever a level change is seen on any of the Port B pins at Bits 4 through 7. However, for the pin's level to be considered as contributing to this interrupt, it must be configured as an input. That is, its TRIS bit must be set.

The way the RBIF interrupt operates internally on the PIC 'C71 is that, during each instruction cycle, the level of the pin is compared (XORed) with the value of the pin that was latched during the previous instruction cycle. A 1 bit is generated by a mismatch on any and each of these pins. The outputs of the comparison for each pin are ORed together and the output of this operation is presented as the input to, and is latched by, the RBIF flag in the INTCON register.

Listing 6*

```
; ***************************** Define Register Addresses
INTCON    equ     0bh             ; Interrupt Control Register
OPTION    equ     01h             ; On Chip Option Register
STATUS    equ     03h             ; On Chip Status Register
TRISB     equ     06h             ; Port B DDR Register
; ***************************** Define Register Bits
GIE             equ     .7        ; Global Interrupt Enable
RBIE            equ     .4        ; Bit Level Delta Interrupt Enable
PAGE            equ     .5        ; Register Page Selection Bit
TrisBVal  equ     .224      ; bit 7=1, bit 6=1, bit 5=1, bit 4=0, bits 0 to 3=0
; ***************************** How to set up the RBIF interrupt on the PIC 'C71.
          bsf     STATUS,PAGE     ; set to register page 1
                                  ; use the following 4 lines if you want bit level
control over the port
          bsf     TRISB,7         ; sets Port B Bit 7 as an input
          bsf     TRISB,6         ; sets Port B Bit 6 as an input
          bsf     TRISB,5         ; sets Port B Bit 5 as an input
          bcf     TRISB,4         ; sets Port B Bit 4 as an output
                                  ; use the following method for initializing the
chip
                                  ; if you look closely at the value of  TrisBVal
you will see that
                                  ; it performs the same operation as the 4
lines above.
                                  ; In both cases, bits 0 through 3 are don't
cares.
          movlw   TrisBVal
          movwf   TRISB
          bcf     STATUS,PAGE     ; set to register page 0
          bsf     INTCON,RBIE     ; enable delta level interrupts
          bsf     INTCON,GIE      ; enable interrupts
```

*This listing must seem rather anti-climactic considering the ordeal of setting up the RTCC interrupt. This is because setting up this interrupt is really simple. Note the characteristic lack of TRIS statements.

This interrupt can also be used to wake up the chip from sleep state.

Microchip envisions that keypads can be easily connected to the PIC 'C71, using Bits 4 through 7 on Port B as inputs dedicated to this purpose. Too bad Microchip didn't include a register mask to provide more information regarding precisely which pin(s) had a level shift that caused or contributed to the interrupt, which would be very useful in certain situations. This interrupt can be set up by merely selecting the pins (Bits 4 through 7) on Port B that will serve as input pins. When configured as interrupts, they're automatically included as part of the interrupt's signal source. Then all that remains to do is enable the interrupts by setting the appropriate bits in the INTCON register. (See Listing 6 for an illustration on how to set up this interrupt.)

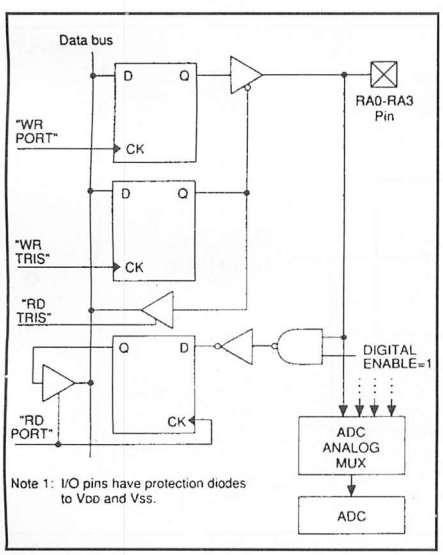
The analog-to-digital converter (ADC) included on the PIC 'C71 is the second internal source of interrupts. Setting up this interrupt involves several internal registers. It also modifies several registers when it fires. But since most of the on-chip resources used by the ADC aren't shared between other on-chip peripherals, it isn't as involved as, say, the RTCC.

Unlike other interrupts on the PIC 'C71, the ADC sets an interrupt flag in the ADCON register, as opposed to the INTCON register. The chip automatically stashes the eight-bit result of the sampled and converted value read from one of the analog input pins in the ADRES register. Regardless of this, you must still set up the interrupt-enable bits in the INTCON register to make the PIC 'C71 respond to interrupts from the on-board ADC. There's a bit more you have to do to initiate an analog sample.

Listing 7*

```
; ***************************** Define Register Addresses
INTCON    equ     0bh       ; Interrupt Control Register
OPTION    equ     01h       ; On Chip Option Register
STATUS    equ     03h       ; On Chip Status Register
ADCON     equ     08h       ; ADC Control Register #0
ADCON1    equ     08h       ; ADC Control Register #1
; ***************************** Define Register Bits
GIE       equ     .7                ; Global Interrupt Enable
ADIE      equ     .6                ; ADC Interrupt Enable
PAGE      equ     .5                ; Register Page Selector
GO        equ     .2                ; ADC kick starter
CHS1      equ     .4                ; ADC Channel Selector (MSB)
CHS0      equ     .3                ; ADC Channel Selector (LSB)
ADCS1     equ     .7                ; Conversion Clock Selector Bit
ADCS0     equ     .6                ; Conversion Clock Selector Bit
ADON      equ     .0                ; ADC power control bit
ADIF      equ     .1                ; ADC interrupt flag
;************************************************
;
; How to set up the ADIE interrupt and initiate an analog
; reading on the PIC 'C71. First you must select a channel to
; sample (the first two lines, set them as you need to) then
; you need to enable interrupts and kick start the ADC
;************************************************
;
          bsf     ADCON,CHS1      ; these are set to read
          bcf     ADCON,CHS0      ; channel 2 on the ADC
                                  ; See Figure 6.6.1 of PIC 'C71 data sheet for
information
                                  ; concerning the selection of the ADC clock.
The sample
                                  ; shown in the next two instructions selects
internal clock
          bsf     ADCON,ADCS1
          bsf     ADCON,ADCS0
          bcf     ADCON,ADIF      ; clear the ADC interrupt flag
          bsf     INTCON,ADIE     ; enable ADC interrupts
          bsf     INTCON,GIE      ; enable interrupts
          bsf     ADCON,ADON      ; power up the ADC
          bsf     ADCON,GO        ; trigger the conversion
```

*This code sample shows you how to initiate the ADC to take an analog reading. First, you select the channel, then you enable the interrupts and, finally, you kick-start the ADC. By now, there should be no surprises, and this code should start looking rather familiar to you.



Details of the meanings of the bits in the STATUS Register.

Like most ADCs, you have to provide it with a "kick" to get it started. With the ADC peripheral built into the PIC 'C71, you do this as follows. First, you select the input channel you want to sample. Then you set the GO/~DONE bit in the ADCON register. When the ADC is done creating the sample, the PIC 'C71 clears the GO/~DONE bit in the ADCON register, and ADC interrupt is initiated. Listing 7 gives the code that does this for you. If you look carefully, you'll notice that Listing 7 could be considered somewhat inefficient because it sets up the bits in the ADCON register using a number of separate BSF instructions. You could conserve some program space by creating an appropriate literal value and using a

(Continued on page 104)

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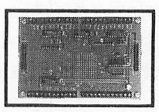

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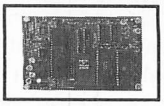

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By Michael A. Covington

Using Bidirectional Parallel Printer Ports

How to exploit bidirectional lines if your parallel printer port has them

Many newer PCs, especially laptops, have bidirectional parallel printer ports that can read as well as write the eight data lines. As a result, the parallel printer port can be used like the bus of an eight-bit microprocessor to send data in both directions, and it interfaces nicely with numerous eight-bit devices. Jan Axelson's recent articles in *MicroComputer Journal* have explored in detail how to use the standard features that all parallel printer ports have in common. In this article, I'll tell you how to exploit bidirectional data lines if you have them.

To avoid misunderstanding, keep in mind that you can transmit data bidirectionally without using a bidirectional parallel port, as long as you do your input somewhere other than the eight data lines. Thus, for example, Eddie McMullen's printer-port voltmeter (*MCJ*, March/April 1994) doesn't require a bidirectional parallel port. "Bidirectional" means that the data lines, not just the status and control signals, are capable of input.

Data-Line Input

To take input through the data lines of the parallel port, you have to do three things: enable bidirectionality, switch the port into read mode and read the data.

Enabling bidirectionality is the difficult part. Bidirectional ports aren't bidirectional unless you explicitly set them up to be. This is to keep older software from accidentally putting the port into read mode by mistake. To make the parallel port bidirectional, you set a jumper (on most newer multifunction I/O cards) or run a setup program (on Toshiba and Zenith laptops, among others).

Listing 1. QBASIC Program to Enable PS/2 Bidirectional Parallel Port

```
'PS2BIDIR.BAS - M. Covington 1994
'For IBM PS/2 Models 50 and up.

'Uses Programmable Option Select (POS) to
'make motherboard parallel port bidirectional.
'Effect lasts until next reboot.

DEFINT A-Z

OUT &H94, INP(&H94) AND &H7F          'unlock POS
OUT &H102, INP(&H102) AND &H7F        'clear bit
OUT &H94, INP(&H94) OR &H80           'lock it back

PRINT "PARALLEL_1 (LPT1) is now bidirectional."
END
```

On an IBM PS/2 (Model 50 or greater), the only way to enable bidirectionality on the built-in parallel port is to run the special PS2BIDIR.BAS program given in Listing 1. This program uses the PS/2's Programmable Option Select (POS) facility to make the parallel port bidirectional. Its effect lasts until you re-boot your computer. With after-market PS/2 parallel ports, you have it easier because you can generally select bidi-

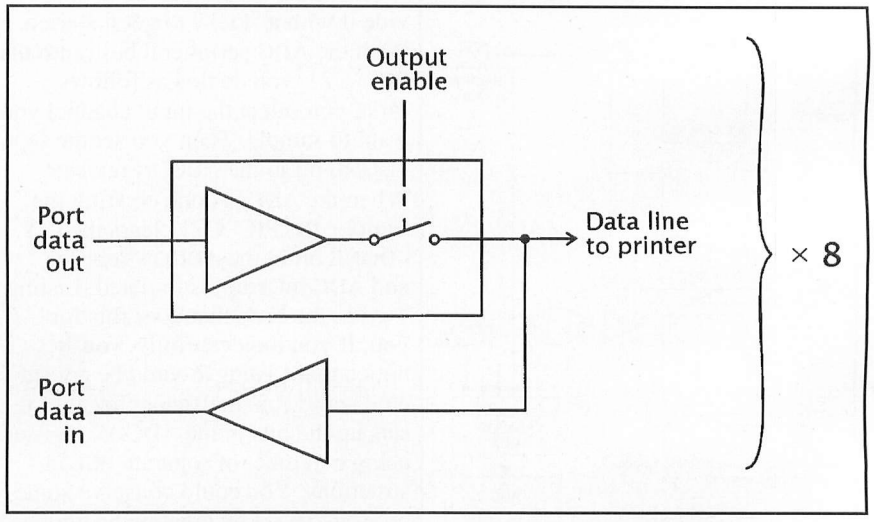

Fig. 1. All PC printer ports can read back their own output. Bidirectional ones can disconnect the output driver to accept input.

Listing 2. Program to Display All Parallel Printer-Port Bits

```
'PPORT.BAS - M. Covington 1994
'Displays all bits of PC or PS/2 printer port
DEFINT A-Z

top:
  CLS
    INPUT "Which LPT port? (1, 2, 3, or 4) ", N
  N = (N - 1) * 2 + 8

'Get port address
  DEF SEG = &H40
  addr = PEEK(N) + 256 * PEEK(N + 1)
  status = addr + 1
  control = addr + 2
  IF addr = 0 THEN
    PRINT "No such port." : BEEP : GOTO top
  END IF

'Output 01010101.  If same pattern is read
'back in, port is probably not bidirectional.
  OUT addr, &H55

'Set direction bit to READ
  OUT control, (INP(control) OR &HA0)
'To undo this: OUT control, (INP(control) AND &H5F)

'Display parallel port bits over and over
  PRINT "Press Ctrl-Break to exit."
  DO
    LOCATE 5, 1
    PRINT "Control bits at", HEX$(control), BIN$(INP(control))
    PRINT "Status bits  at", HEX$(status), BIN$(INP(status))
    PRINT "Data bits    at", HEX$(addr), BIN$(INP(addr))
  LOOP
  END

FUNCTION BIN$ (i)
  'Like HEX$, but binary.
  j = 128
  s$ = ""
  WHILE j > 0
    IF (i AND j) <> 0 THEN
      s$ = s$ + "1"
    ELSE
      s$ = s$ + "0"
    END IF
    j = j / 2
  WEND
  BIN$ = s$
END FUNCTION
```

```
Which LPT port? (1, 2, 3, or 4) 1
Press Ctrl-Break to exit.


Control bits at       3BE       11001100
Status bits  at       3BD       01111111
Data bits    at       3BC       11111111
```

Fig. 2. Output of PPORT.BAS is this continuously updated display.

rectional mode in the setup program on the Reference Diskette.

With bidirectionality enabled, the port is still an output device and still drives a printer in the usual way until you switch it into read mode by setting Bit 5 or 7 in the control register. There's no harm in setting both bits.

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```
#include <PIC16C56.h>
#fuses xt,protect
#use Delay(Clock=20000000)
#use RS232(Baud=9600,Xmit=pin_1,RCV=pin_2)

main () {
   printf("Press any key to begin\n") ;
   getc();
   printf("1 khz signal activated\n") ;
   while (TRUE) {
        output_high(pin_8) ;
        delay_us(500) ;
        output_low(pin_8) ;
        delay_us(500);
   }
}
```

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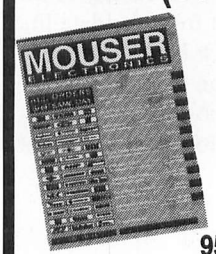

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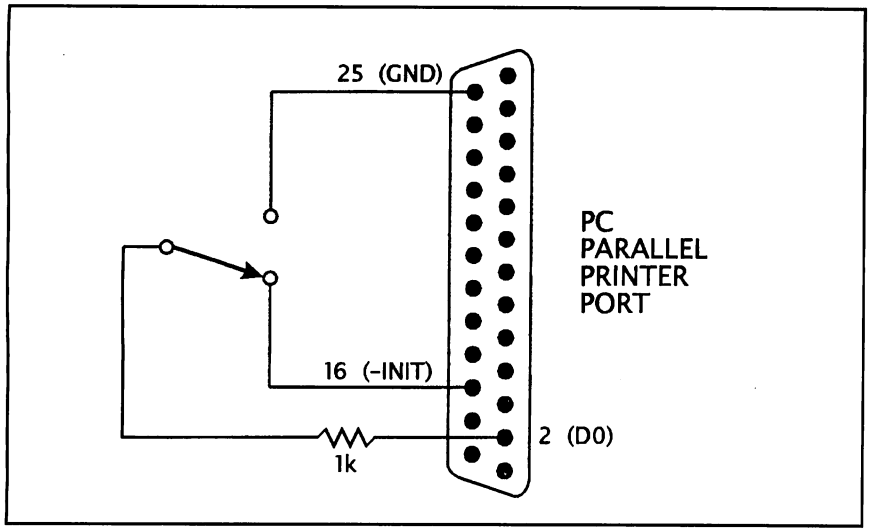

Fig. 3. Simple demonstration of input through a parallel-port data line. –INIT line is normally high (+5 volts).

Some computers use one and some use the other. In BASIC, the instruction to do this is:

```
OUT control, INP(control) OR &HA0
```

where *control* is the address of the control register (the parallel port base address plus 2). For example, if the port is at hex 0378, control will be hex 037A. To get back into write mode, key in:

```
OUT control, INP(control) AND &H5F
```

Implementing Bidirectionality

Illustrated in Fig. 1 is how bidirectionality is implemented. All parallel printer ports have the ability to read back the data that's output to them. The original IBM PC used this feature for testing. The only thing new in a bidirectional port is the ability to disconnect the output from the data line, while the read-back inputs remain connected. You can read these TTL-compatible inputs by taking input from the base address of the parallel port as follows:

```
result = INP(addr)
```

where *addr* is hex 037C, 0378, or 0278, as the case may be. The data bits aren't inverted. Each is 0 if low and 1 if high. Disconnected pins usually read as 1 but may pick up random noise if your parallel port uses CMOS or NMOS technology.

If the port is still in write mode and you try to read it, you'll get back whatever data was last written to it. You can exploit this fact to test whether a printer port is really bidirectional by writing a distinctive bit pattern to it (not 11111111 or 00000000, which might correspond to disconnected pins), switch the port to read mode (or try to) and see if you get the same bit pattern when you read it. If you do, the port is almost certainly not bidirectional, or at least isn't really in read mode.

PPORT.BAS Listing 2 is a program that puts all this together. Figure 2 shows how it displays all the bits of all three parallel-port registers. To demonstrate that a port is bidirectional, use the circuit in Fig. 3. The lowest data bit should toggle back and forth as you flip the switch. The 1,000-ohm resistor protects the parallel port against shorted outputs in case it turns out not to be in read mode when you perform the test.

Figure 4 shows how to approach

Listing 3. Program to Read Data From Analog-to-Digital Converter

```
'ADC0803.BAS - M. Covington 1994
'Interfacing an analog-to-digital converter
'through a bidirectional parallel port

  DEFINT A-Z
  CLS

'Assume it's LPT1; see PPORT.BAS
  N = 8

'Get port address
  DEF SEG = &H40
  addr = PEEK(N) + 256 * PEEK(N + 1)
  control = addr + 2

'Set direction bit to READ
  OUT control, (INP(control) OR &HA0)

'Initialize ADC by taking STROBE low,
then high
  OUT control, (INP(control) OR 1)
  OUT control, (INP(control) AND &HFE)

'Display data over and over
  PRINT "Press Ctrl-Break to exit."
  DO
    LOCATE 5, 1
    PRINT INP(addr); "  "
  LOOP
  END
```

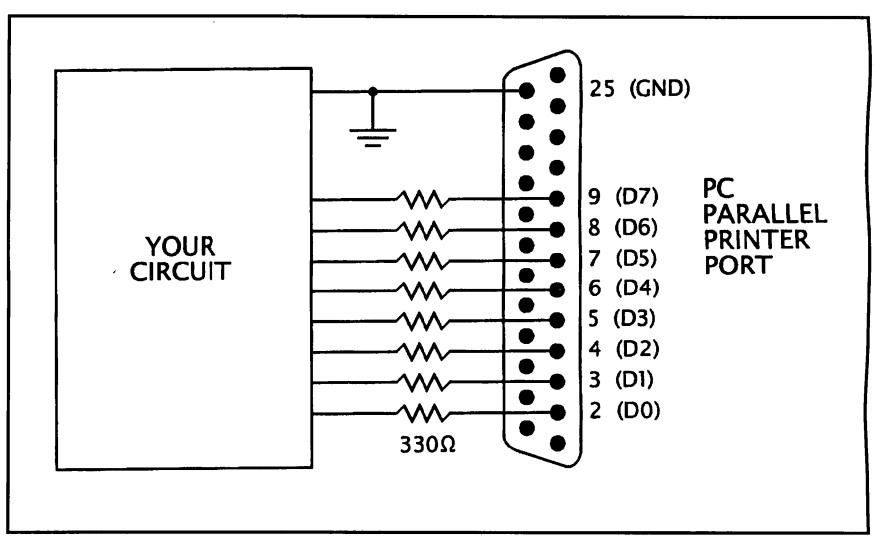

Fig. 4. General scheme for interfacing to bidirectional parallel port. Resistors protect ICs when both devices are in output mode.

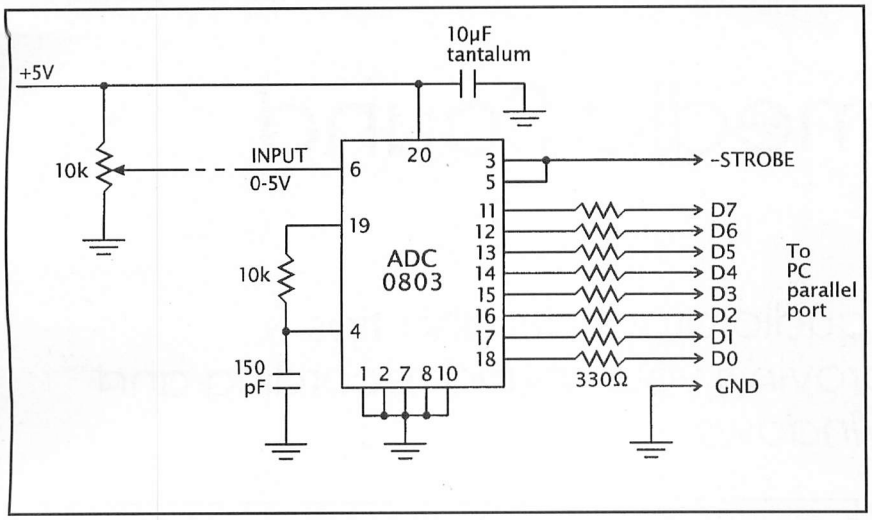

Fig. 5. Designed for eight-bit microprocessor bus, ADC0803 A/D converter interfaces equally well to bidirectional parallel port. ADC0801, 0802, 0804 and 0805 work in this circuit. Potentiometer varies input voltage for testing purposes.

interfacing. Protective resistors are required because the parallel printer port is an *output* device from the moment your computer boots up until you put it into read mode, yet is connected to the outputs of your external equipment. Shorting outputs to each other can easily damage logic ICs unless current is limited to a safe level.

The 330-ohm resistors pass TTL-level signals transparently but limit current to 10 mA when a low output gets shorted to a high output, or vice-versa. This is a good use for the 330-ohm resistor packs that once were used as terminators on diskette drives. If your parallel port has MOS inputs (most bidirectional ones do) and you're using the data lines for only input, not output, you can usually get away with much larger-value resistors for added safety.

Interfacing

Shown in Fig. 5 is a practical interfacing setup. An ADC0803 analog-to-digital (A/D) converter reads its input voltage (0 to +5 volts) as a value from 0 to 255. ADC0803.BAS Listing 4 is a program that accepts the input and displays it. The eight data lines carry the data, through 330-ohm protective resistors. The strobe line is used to reset the ADC so that it will start running at the beginning of a session. No protective resistor is needed because, unlike the data lines, the strobe line isn't a TTL totem-pole output. It's open-collector, with a 4,700-ohm pull-up resistor, and can't drive excessive current into the ADC.

Finally, a word about "brute-force bidirectionality." Some experimenters have found that a standard (unidirectional) PC parallel port can work bidi rectionally if driven by a circuit that can sink a lot of current (like 20 mA) in the low state. The technique is to write all 1s to the base address of the port and then pull some of the data lines low and read the data back in. Sure enough, the lines that are pulled low read back in as 0, not 1. But this technique risks overheating the output chip (originally a 74LS374, nowadays often a special NMOS or CMOS LSI circuit).

A better technique, if you have an original IBM parallel port or close equivalent, is to find Bit 5 of the control register (it's decoded at the output of a 74LS174 but never used) and route it to the output-enable pin of the 74LS374 that drives the data lines. This will require a bit of circuit tracing and shouldn't be done blindly.

The alternative is to just buy an I/O card that includes a new-style bidirectional parallel port. Be wary of connecting experimental circuits to your main I/O card if it includes disk controllers and other vital parts of your PC. Such ports are very vulnerable to static damage, and when zapped, they crash the whole computer. ■

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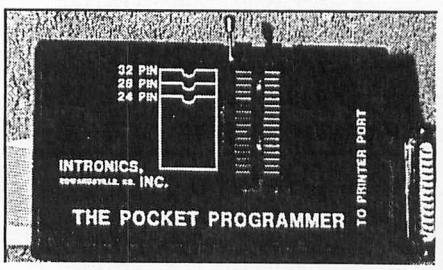

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By Tom Benford

The Multimedia Sound Garden

Better multimedia audio products and tips & techniques for improving your sound recording and playback under *Windows*

Putting together impressive multimedia presentations is a fairly easy thing to do nowadays, thanks to easy-to-use industrial-strength applications like Asymetrix's *Multimedia Toolbook*, AutoDesk's *Studio* and others. This is why I'm always surprised and sometimes dismayed when I see a slick presentation or demo that has an inferior sound track.

In such presentations, it seems that all the effort and attention went into creating dazzling visuals, titles and special effects and the audio was created as an afterthought. This puzzles me because recording audio that sounds truly excellent during playback isn't rocket science by any stretch of the imagination. All it takes is a little common sense, some decent, but very affordable, equipment and planning.

Before I get into specific product recommendations, I want to go over a few general rules that, if observed, will immediately improve the quality of your digital audio recordings.

Foremost to keep in mind is that the quality of an input signal to be recorded ultimately affects the quality of the output. While you may be able to clean up a less-than-optimal recorded .WAV file to some extent, don't expect miracles. You'll never make a poorly recorded sample sound as good as one that was recorded better to begin with.

One of the easiest ways to improve a sound track is to record and assemble your sound bites first on an external recording device, such as a cassette player or a DAT recorder, if you have one. The reason for this is that recording directly onto your hard drive via a microphone is rarely, if ever, an optimal situation due to the extraneous noise of the PC's fan, ambient room noise, telephones and doorbells ringing in the background, outside traffic sounds, etc., cluttering the sound track.

Table 1. Audio Sampling Rates

Sampling Frequencies (kHz)	11.025, 22.05, 44.1
Bits Per Sample	8 (256 Samples)
	16 (65,536 Samples)

Sampling Frequency shows the interval, or how often, the sound is measured, while the Bits Per Sample determines how much information about the sound is stored to the file.

If you use a cassette player, you have more mobility to find a quiet spot to record your narrative. You can also do multiple takes on the cassette, or re-take "goofs" that you can cut and paste later when you digitize the audio.

You can record excellent-quality audio with an inexpensive Walkman-type cassette recorder by using a better grade of tape than the cheapie $1 C-60 variety you can routinely find on sale. Spending a few cents extra here can make a world of difference in reducing tape hiss and increasing dynamic frequency range, which is particularly desirable if you'll be recording music along with your narrative.

Though most portable cassette recorders have built-in condenser microphones, these never yield the best-quality recording. You'll usually find a jack for plugging in an external microphone, which is definitely the way to go.

Aside from finding a quiet place to do your recording, the close-miking technique will substantially improve the quality of your narratives. Originally conceived and developed by Les Paul, inventor of the electric solid-body guitar, close miking consists of placing the microphone as close to the source of the sound as possible—for example, your mouth when recording vocalized sounds.

In the early days of sound recording, the microphone was kept some distance (2 to 3 feet) away from the speaker or singer to avoid pops and other breath noises. Through experiments with microphone placement while recording vocals by his wife, Mary Ford, Les Paul found that positioning the mike to the side of her mouth substantially reduced the unwanted pops and other noises, while the increase in the overall recorded signal's quality and volume made for a much cleaner recorded track. Further experiments by Les produced foam wind screens and pop filters, both of which are standard equipment in modern recording studios.

Microphones come in several different types, with prices for them ranging from about $20 to several hundreds of dollars. Generally speaking, you get what you pay for. Just bear in mind that you won't need a $500 Sennheiser electret condenser microphone to obtain good sound, especially if your final sample rate

Table 2.
Sound Quality Vs. Sampling Frequency and Bits Per Sample

Bits Per Sample	11.025 kHz	22.05 kHz	44.1 kHz
8	Lowest Quality	Good Quality	Very Good Quality
16	Acceptable Quality	Very Good Quality	Highest Quality

Higher sampling frequencies at 16-bit rates produce best sound quality but require more data resulting in larger file sizes. 16-bit sound sampled at 44.1 kHz results in highest possible sound quality and is data rate used by audio compact discs, but few multimedia applications require this extraordinarily high-quality sound.

Table 3. Audio Files in Bytes Per Minute

Bits Per Sample	11.025 kHz	22.05 kHz	44.1 kHz
8	66,150	1,323,000	2,646,000
16	1,323,000	2,646,000	5,292,000

You can get by with eight-bit sampling for vocalized files, but music requires 16-bit sampling. The better the audio quality desired, the more data required and the larger the resulting size of the audio file.

and depth are going to be less than 16 bits at 44.1 kHz and it probably will be.

Squeezing the Sound

Audio data can be compressed to produce smaller audio file sizes. However, bear in mind that you must consider some tradeoffs regarding sound quality in relationship to file size.

Sound frequency is measured in Hertz, abbreviated Hz. One period per second equals one Hertz (1 Hz); 1,000 Hz equals one kilohertz (1 kHz). Because 1 Hz is so low in frequency, it can't be heard by the human eardrum as a sound. The average range of human hearing is 20 Hz to 20 kHz.

Converting analog sound to digital format requires use of a sound-capture program and an audio card in the PC that samples the analog waveform. The sound recorder accessory is a "bare bones" sound-capture program that comes as a standard part of *Windows*. These samples, or measurements, describe the shape of the analog waveform. The more samples taken, the more-accurate the digital representation (Table 1).

Two types of samples are required to recreate an analog waveform: sampling frequency and bits per sample (Table 2). Sampling frequency measures the sound frequency at regular intervals. The greater the sampling frequency, the more often these intervals occur. Bits per sample determines how much information about the sound amplitude is stored in the file. For example, a 16-bit sound file sampled at 22.05 kHz contains much more information than an eight-bit sound file sampled at 11.025 kHz.

Striking a balance between the audio quality you desire and the amount of disk space and audio data overhead that will be added to the video data stream depends, to a large extent, on the type of audio material contained in your sound track.

In addition to sampling rate and frequency, one other factor should be considered. This is the number of channels you plan to use. Simply put, this refers to whether the sound track will be stereo or monophonic. Not surprisingly, stereo sound requires twice the amount of data as a monophonic track, since it contains double the information for the separate data in the left and right channels.

With your objective being to achieve the highest quality sound with the smallest possible files, the first step is to evaluate the type of sounds you'll be using. A rule of thumb is that sampling frequency should be twice the greatest frequency in the sound you're digitizing. For example, acceptable quality for speech is usually obtainable at eight-bit rates, whereas music requires 16-bit sampling to sound good. Similarly, the human voice is well within the range that can be handled by an 11.025-kHz frequency rate. Singing and music, however, require a minimum frequency rate of 22.05 kHz to sound good.

You can determine the size of an audio file by multiplying the frequency rate by the bits per sample and dividing the result by 8. This gives the number of bytes per second. Multiplying this figure by 60 yields the number of bytes per minute, and multiplying this number by the total number of minutes gives the size of the file. Remember to multiply the result by 2 for stereo, which contains two channels of audio data (Table 3).

You're in a better position to experiment with compression and sampling rates after you have your sound elements already assembled and mixed so that you're dealing with only a single sound source. By recording and mixing to a cassette or DAT deck, you can optimize compression when you digitize the file. Mixing several different sound elements doesn't give you this freedom.

As an example, say you've digitized a narrative passage at 11.025 kHz with an eight-bit depth and the background music is 22.5 kHz at a 16-bit depth. You may also have some high-pitched sound effects digitized at 22.5 kHz at an eight-bit depth. Mixing together these digital files is both cumbersome and requires an industrial-strength sound software application like *Sound Forge* 3.0 (see the review in my Multimedia Column in the September/October issue of *MicroComputer Journal*). The entire process will be much easier and the resulting sound file will have better all-around quality by mixing the elements in analog format first, prior to the conversion to digital.

Microphones

Several different microphone configurations can be used with great success in recording audio for your multimedia work. However, selecting the correct one for the particular task at hand is important. It's conceivable that you won't always be recording in a quiet indoor location. For such occasions, there are some other microphones that may do a better job of recording your "location" sound.

As you may already have surmised, there's a fairly extensive variety of microphones on the market. Though low-cost "general-purpose" microphones abound, you should be aware that there are specialized types that are designed to meet particular needs.

The following is a brief run-down on commonly available microphones.

• ***Hand-Held & Boom Models.*** Hand-held or boom-mounted microphones are excellent for recording sound because they can easily be moved close to the source or follow a moving source. As with all the other types of microphones, use of a foam windscreen (usually supplied with the microphone) is recommended for cutting wind noise when recording outdoors. When holding a microphone in your hand as you're recording, use a solid, firm grip because any movements of your hand or fingers on it will produce unwanted sound.

• ***Professional Models.*** Professional-level microphones do the best job of recording sound, since they're specifically designed to capture audio from a very specific range around the mike. These are referred to as directional microphones because they have specialized directional pick-up patterns.

Unidirectional microphones can pick up sounds primarily from one direction, usually from directly in front of the mike. These microphones are best suited for situations where lots of ambient noise is present. You can aim a unidirectional microphone directly at the source of the sound, such as the speaker's mouth, and the mike's narrow reception band will pick up the voice while the other ambient sounds are greatly subdued.

Omnidirectional microphones have a greatly increased pick-up range, with some models being capable of full 360° pick up patterns. These microphones are good for situations where sound is coming from several directions, as when several speakers are seated around a desk or you want to record all of the ambient sound occurring during the event.

• ***Lapel & Lavaliere Models.*** A lapel microphone, either wired or wireless, clips onto a lapel. These microphones are great for interviews, recitations, announcing and other vocal audio coming from the subject and for doing your own narratives when your hands are otherwise occupied. Because of its proximity to the sound source (your mouth), the volume level and audio quality of a lapel microphone is typically very good.

One of the problems of lapel microphones, is that they may also pick up unwanted sounds, such as the rustle of clothing or other sounds if the subject moves around too much.

Lavaliere microphones are those miniature-sized ones you usually see hanging around the necks of TV newscasters. They're highly desirable because they deliver the outstanding sound quality that close-miking produces, yet they're practically invisible, which may be a significant consideration if you're recording video of the subject as well.

The best lavaliere microphones are condenser types that use an internal battery for power. My personal favorite for this genre of microphone is the Audio-Technica ATR35s.

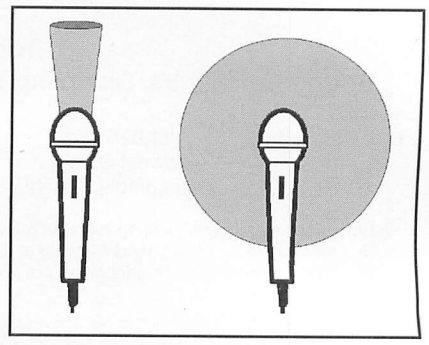
Some of the features I like best about the ATR35s are its inclusion of a convenient on/off switch that cuts audio input from the mike and conserves the battery. Another feature I feel is a big plus is the 20-foot cable length of the ATR35s. This extended-length cable gives me plenty of working room for optimal positioning when I'm doing sound work on location, without having to use a wireless microphone. This simplifies setup and lessens the amount of equipment I have to lug around.

The 3.5-mm mini-plug is permanently attached to the microphone cable, and an included 1/4" phone plug adapter permits it to double as a narration microphone when I'm recording narrative tracks on a cassette or DAT recorder for later mixing prior to digitizing.

Supplied with the ATR35s are a foam windscreen, tie-clip holder and battery. Its sound quality is quite impressive, being that the microphone is sensitive enough to pick up a whisper while being very tolerant, almost to the point of immunity, to rustling from clothing and other forms of extraneous noise.

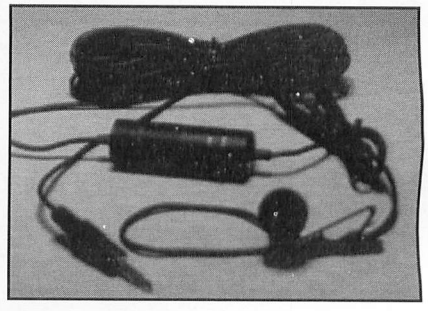
• ***Alternate Hand-Held/Mountable Models.*** I use an assortment of microphones for different applications, which range from recording sound via a camcorder while shooting video, recording background sound on location and recording sound effects, specific sound bytes, quotes and, of course, music.

Numerous brands of microphones are available. What you use will be a matter of personal preference and how much you can afford to spend. I've been a big fan of Audio-Technica microphones for a long time now because the sound clarity they provide is uncompromising and these microphones are utterly dependable (this is *very* important to me).



Photos/illustrations/videographs by Tom Benford

Differences in sound pickup patterns between unidirectional and omnidirectional microphones is illustrated here. The unidirectional microphone at left has a narrow reception band for sound, while the omnidirectional mike at right can receive sound from all directions.



The miniature size of the Audio-Technica ATR35s lavaliere microphone belies the professional sound quality it delivers. Among the features that make it a hit are its 20-foot cable and on/off switch that provides convenience while conserving the mike's battery.

In addition to being used on location, these microphones frequently find their way into my audio recording studio and editing suite for double-duty use in recording narratives, voice-overs and vocal tracks for some of my musical scores. On more than one occasion, I've used various Audio-Technica microphones for recording sound effects and ambient audio, such as those of a big Harley-Davidson V-Twin shifting through the gears and crowds cheering at a political rally.

Having the right tool for a particular task makes the going easier, and the result is invariably better than trying to "make-do" with a substitute.

Audio-Technica's extensive microphone product line. All are great for use in multimedia work, and several come with accessory shoes for mounting directly on microphone stands and/or camcorders. They deliver quality, reliability and excellent sound at very reasonable prices.

For this reason, I have an assortment of microphones in my equipment locker to keep me well covered for just about any situation I'm likely to encounter in my multimedia, video and desktop-video production work.

Audio-Technica's special-purpose ATR25 and ATR55 microphones are ideal for independent sound recording and multimedia audio/video capture tasks because they're specifically designed for use with camcorders. Both come with accessory-shoe mounts and microphone-stand adapter bases.

The ATR25 is a dual unidirectional stereo condenser microphone, while the ATR55 is a unidirectional model that provides a switch for selecting normal or "tele" shotgun long-distance pickup patterns. In addition to the camera accessory shoe mount, the ATR55 comes with a pistol-grip microphone stand clamp that's excellent for hand-held miking.

Audio-Technica's ATR20, ATR30 and ATR40 unidirectional microphones vary in frequency response and sensitivity ratings. All three are far above the normal specifications for typical "standard-equipment" cassette recorder or sound card microphones. All are also in the familiar "ball-end" configuration and feature convenient on/off switches.

The ATR20 is equipped with a permanently-mounted 16.5-foot cable that's terminated in a 3.5-mm miniplug. It comes with a 1/4" plug and a desk stand.

The ATR30 and ATR40 have detachable 16.5-foot cables that are terminated in XLR jacks on the end that mates with the microphones and 1/4" phone plugs on the opposite end. These models are supplied with microphone-stand clamps and feature rugged metal construction, rather than the plastic housing used for the ATR20.

The AT835a is a wide-range condenser microphone that was specifically designed for long-distance sound pickup. Created for use in professional recording, broadcasting and film/TV/video sound, it's exceptionally well-suited for demanding sound pickup applications requiring excellent sound rejection from the sides and rear. This is definitely an upscale piece of equipment that will appeal to professionals and other users who have serious applications that demand this caliber of gear.

I've found this microphone to be terrific for recording "nature" sounds, such as animals being taped using the camcorder's telephoto settings. Usually, when you're shooting such distant subjects, you won't get acceptable sound (if any sound at all) due to the distances involved. However, the AT835a, in effect, acts like a telephoto "lens" for the sound.

This 15"-long mike is also uniquely suited for both boom and hand-held use. It comes with a microphone-stand clamp.

Audio-Technica's AT822 OnePoint X/Y Stereo Microphone is a stereo condenser model that has full monophonic capabilities as well. Originally designed for DAT recording use, the AT822 is a sterling performer for hand-held and boom-mounted use in multimedia productions because it provides full, natural stereo ambiance in a compact and lightweight design.

It provides true stereo ambiance (crowd noises, music, etc.) mixed-narrative content combined on a center mono channel. Since it permits "in-mike" mixing of audio coming from different directions, it's a really handy tool for on-location audio recording. The AT822 delivers excellent channel separation and features a three-position switch that lets you select left and right stereo only, left and right stereo with center mono or off setting.

Accessories supplied with the AT-822 include a pistol-grip snap-in stand clamp for standard microphone stands, camera accessory shoe mount adapter, battery, windscreen, detachable 1.7-foot cable and soft vinyl protective carry pouch.

If you're looking for the *creme de la creme* in microphones for use in field audio or audio/video production, the AT822 will fill the bill.

Audio-Technica's newest additions to its microphone line are specifically designed for multimedia computer applications. The MT858 is a universal computer gooseneck microphone that has a cardioid (unidirectional) pickup pattern. It was designed for use with voice-recognition and multimedia applications.

This microphone and its base are enclosed in a rugged housing with a low-reflective black finish. The weighted base houses the microphone's on/off switch and other components, controls for a unique universal interface system and the battery compartment. The small-diameter alternating gooseneck design permits highly flexible positioning, and you can swing it out of the way when not in use.

The MT858 is equipped with a 3.5-mm "stereo" mini-plug output that mates with the audio input connector on most sound cards. A universal interface system has DIP switches on the bottom of the microphone's base so that you can adjust its impedance to achieve compatibility with the sound card in your PC. A level control permits you to adjust the audio output over a 20-dB range. The microphone can derive its operating power from a standard 1.5-volt AA cell or a 5- to 52-volt dc supply, either balanced or unbalanced. Frequency response is rated at 120 Hz to 18 kHz, which is comfortably within the range of most multimedia recording applications.

Also new from Audio-Technica, the ATR65, is an economy-priced computer microphone that doesn't skimp on sound quality. It has a condenser element and a unidirectional pickup pattern with a rated frequency response of 100 Hz to 16 kHz. Its 6-foot cord is terminated in a 3.5-mm "stereo" mini-plug. Since the 1.5 to 9 volts dc power required for the microphone comes from the sound card, you don't need batteries.

This miniature microphone fits securely in its supplied mountable base

or clips onto your clothing, if desired. Its unidirectional polar pickup pattern enhances voice pickup while minimizing undesired sounds from the sides and rear of the microphone. Like the MT858, the ATR65 is particularly well-suited for voice-recognition tasks and general multimedia recording uses.

Signal Processors

A good microphone is where excellent sound tracks begin, but there are some other tools you can use to further enhance the quality of the sound. Probably the handiest and most versatile of the available signal processors for "sweetening" sound quality is a compressor/limiter/noise gate. My personal choice here is the Phonic PCL-3200, which is a mainstay in my studio.

A compressor/limiter/noise gate is a signal processor that reduces the dynamic range of audio signals and prevents them from exceeding a given threshold level. A threshold control sets the level of compression applied to the input signal and, thus, prevents distortion in the recording and protects the amplifier and/or speakers during playback.

An attack control is used to set the compression attack time interval between the input peak signal and the threshold setting. A release control decides the decompression interval for a compressed signal to return to its original value.

The noise-gate section of the signal processor turns off or significantly attenuates the audio signal passing through it when signal level falls below a user-adjustable threshold.

Put in its simplest terms, when set up correctly, the compressor/limiter/gate controls can smooth out variations in the volume of an incoming signal to maintain a steady level without unduly loud or soft passages.

The PCL-3200 is a rugged unit that can mount in a rack and uses top-of-the-line components throughout. Its front panel is quite busy, providing a home to 16 rotary controls, 11 switch buttons, four 10-segment LED meters and an on/off switch.

Compressor/limiter section controls for each channel include Threshold, Attack, Release, Ratio and Output. A dedicated gain-reduction meter for each channel displays the amount of compression from –30 to –1 dB. A switch-able LED "meter" lets you monitor each channel's signal input or output levels.

Another noteworthy feature of the PCL-3200 is its "de-essing" capability, which is used to remove excessive sibilance. This is a particularly nice feature, especially if your (or your subject's) speech tends to exaggerate the "s" sounds of words or either of you has a slight lisp.

The rear panel of the PCL-3200 has on it six 1/4" phone jacks, three each for Channels A and B. These jacks are in stereo configuration. The plugs used in them can be wired with the tips for signal return, with the middle band for signal send, permitting each jack to do double duty. Each channel has a jack for input, side-chain and output, and each is equipped with a in/out level slide switch that permits selecting either –10 or +4 dB.

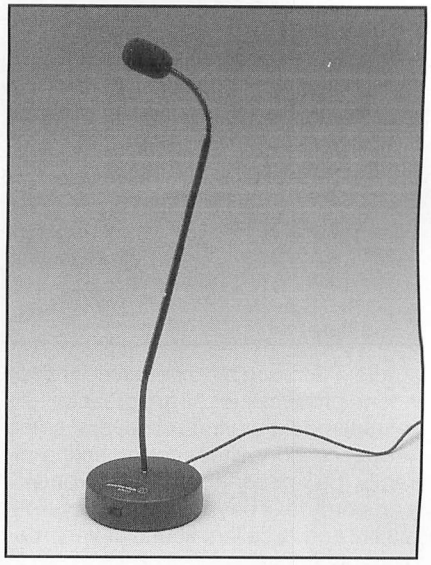
Like any other sophisticated piece of equipment, using the PCL-3200 to maximum advantage takes time and experimentation, although its excellent user manual helps you get some remarkable results immediately. If you really want to add sparkle to your audio, this piece of equipment is second only to a good microphone.

Speaker Systems

Good multimedia audio is a two-way street. After you've gone to the trouble of recording the cleanest signal at the optimal sampling rate and depth, it doesn't make sense to play back the audio through a chintzy pair of speakers. A good speaker setup can enhance the sound of your audio considerably by giving it more bottom end, clear and crisp mid-ranges and sparkling high frequencies. Don't underestimate what good speakers can do!

Several of the "home-stereo" companies have recently jumped onto the multimedia computer speaker bandwagon. These products are good, albeit pricey.

Labtec, one of the oldest names in the computer industry, has been around for years and has devoted all of its attention to making speakers and audio products specifically for the multimedia industry, rather than as a sideline. Its experience and expertise are evident in the sound of the speakers the company markets.



Audio-Technica's MT858 gooseneck microphone is and ideal desktop electret condenser unit that features adjustment switches to achieve compatibility with virtually every sound card in existence.

Labtec's newest SB-8 and LCS-3210 speaker systems reaffirm why this company makes America's number-one selling computer speakers. The three-piece subwoofer/satellite SB-8 system literally delivers home-theater sound quality with an impressive frequency range of 30 Hz to 20 kHz. The subwoofer features a dual-voice-coil 8" woofer that's computer-matched to a compact bandpass enclosure to produce powerful bass from 30 to 150 Hz.

A 150-Hz electronic crossover eliminates midrange energy from the subwoofer to produce non-directional bass and permit out-of-the-way subwoofer placement. The dual magnetically shielded satellite speakers feature high-performance 3" drivers that provide smooth response from 150 Hz to 20 kHz.

A master volume control is conveniently located on the right satellite speaker for ease of use, along with dynamic bass boost and treble buttons. There's also a headphone jack for private listening.

All cables required for hookup are provided, as is the 14.4-volt, 1.6-ampere ac/dc adapter. Power output for the subwoofer is rated at 20 watts rms and 40 watts peak, while the satellite speakers are rated to deliver 3.5 watts

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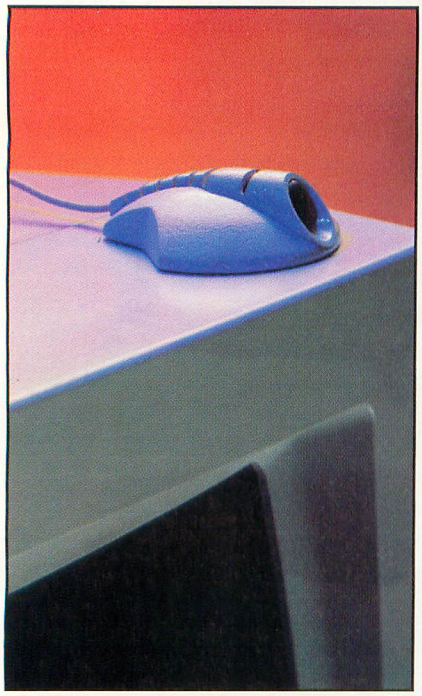

The Audio-Technica ATR65 computer/ lavaliere microphone is a low-cost, high-quality condenser model that offers excellent sound quality and a variety of mounting options.

rms per channel with 14 watts total peak power. This system is a real treat to the ears.

Labtec's LCS-3210 amplified computer speakers put a new twist on multimedia sound by delivering Spatializer 3D audio technology. Spatializer technology creates a vivid, expansive and interactive three-dimen- sional surround-sound listening experience from just two speakers. The sound appears to come from all around you. Spatializer's exclusive and patented Double Detect and Protect (DDP) circuitry permits enhancement of previously encoded 3D stereo source materials without over-processing.

Each of the two tall slim-line speaker enclosures contains a 3¼" Max-X high-excursion woofer and ⅝" dome tweeter. They're magnetically shielded to protect your video monitor, hard drive and disk storage. There's also a subwoofer output jack on the back to permit adding an optional subwoofer, if desired.

The LCS-3210s deliver 20 watts rms into a 4-ohm load (both channels driven) at a rated frequency response of 48 Hz to 20 kHz. An ac power adapter and all required cables are supplied, with 6-foot cable lengths affording plenty of leeway for speaker placement. The Spatializer effect isn't a gimmick. In fact, the effect is quite astonishing, and it really gives new dimension to multimedia audio.

Final Mix

Having all of the right tools at your disposal certainly makes any job go faster and smoother, but the most-important elements of any project are planning and forethought. I can't emphasize this enough.

Having a script of the vocal audio passages to be recorded is essential. Don't try to ad-lib what you want to say. Write down and edit (and re-edit, if necessary) your narratives or other spoken audio bytes so that you can concentrate on your pronunciation, enunciation and inflection, rather than fishing for the right words.

Prepare an audio storyboard with time cues. This way, you'll know precisely how long each segment is supposed to take, when music and/or sound effects should be introduced into the sound track and where periods of silence or pauses should be. By timing each segment, you can adjust the speed of your narration slower or faster to fit the slot.

Do multiple takes, and listen to them with a critical ear to select the very best of the bunch. If necessary, manually adjust the volume of each segment (or use a compressor/limiter/gate unit) to give the entire sound

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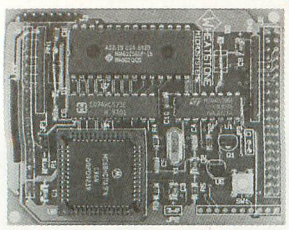

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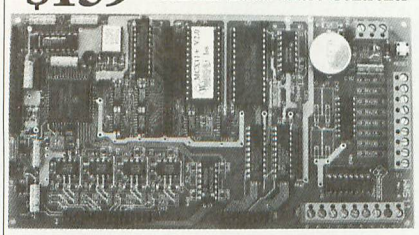

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Phonic's PCL-3200 Dual-Channel Compressor/Limiter/Noise Gate is an excellent signal processor for improving sound quality of multimedia soundtracks. Priced at less than $300, it's one of the best and most-versatile tools available for "sweetening" audio. This unit is considered indispensable by professional sound recordists.

track a consistent level.

By all means, experiment and be creative. There's no substitute for experience, and you gain experience by trying different things hands-on to learn what works best. You'll be amazed at how you can sculpt audio and shape sound just by slightly varying elements and, in the process, you'll gain a new appreciation of what it takes to produce the high-level audio we hear on radio and TV and take for granted every day.

The tips, techniques and equipment recommendations I've presented here are good starting points, but there's only so much I can cover in an article. If you want to learn more about audio techniques, sound files, compression rates, sound cards and other aspects of PC audio, I recommend you get a copy of *Welcome To...PC Sound, Music and MIDI*, which I also wrote. I cover these subjects in depth in this book. You can order a personalized copy directly from me at the address given in the Products Mentioned box, and I'll be happy to inscribe it for you. (Checks or money orders only, made payable to Tom Benford, please).

One last bit of advice: have fun! If your recording doesn't sound the way you want it to at first, do another take. After all, Rome wasn't built in a day, and, believe me, the first take is almost never a keeper. Approach the process of multimedia production with an airy, creative mindset, rather than a tense and critical one, and you'll enjoy it more. You'll be more productive in the long run, too! ■

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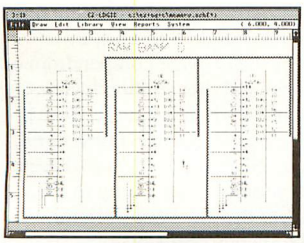

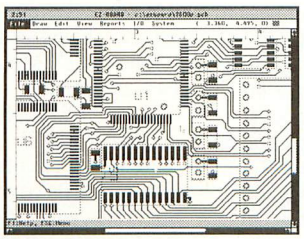

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Product Review By Alexander W. Burawa

Virus Vanquisher—*Dr. Solomon's Anti-Virus Toolkit*

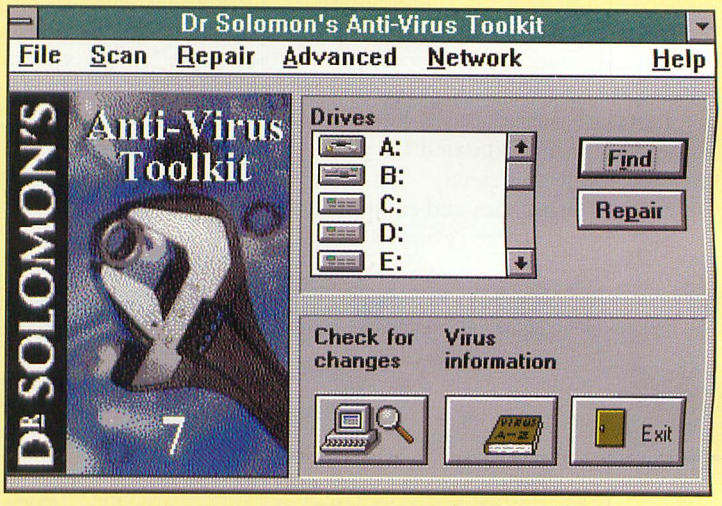
Just as I began to work on the September/October issue of *MicroComputer Journal*, the computers I use in the office and at home were struck by virus activity that put my deadline in jeopardy. It took me 17 days to get back on line, all the while frantically trying one anti-virus program after another with no success. What saved the day and made it possible for me to get the issue out on time was a program heretofore unknown to me: *Dr. Solomon's Anti-Virus Toolkit* from England, which is distributed in the U.S. by S&S Software International in Burlington, MA.

What made the particular virus particularly difficult to eradicate was that it wasn't even thought to be in circulation at the time my PCs were infected with it, which meant that most of the software I tried didn't even detect its presence. Neither the Microsoft MSAV anti-virus utility that comes with MS-DOS 6.22 nor the anti-virus utility that's built into *Windows for Workgroups* 3.11 were successful in uncovering the virus, much less eradicating it. A well-known and respected anti-virus program located and identified the virus, calling it the DA'BOYS, and cleaned it out of my office system with a "generic 2" procedure. Unfortunately, generic 2 was less than effective because every time I warm- or cold-booted my PC, the virus returned and was reported as having been cleaned out. I had similar lack of success with a few shareware and freeware programs.

Having exhausted the anti-virus programs known to me, I was ready to order new hard drives for both my PCs, install them in place of the infected ones and set them up as needed when columnist/author TJ Byers told me about *Dr. Solomon's Anti-Virus Toolkit*. A call to S&S Software started my systems on the path to recovery. Within 10 minutes after its arrival, I had *Dr. Solomon's* on my home system and had cleaned out the DABOYS virus (*Dr. Solomon's* name for it). Having experienced multiple failures to clean this virus from my systems before, I was leery. So, just to be on the safe side, I cold-booted my system several times, each time running the clean utility to make certain that the system was, indeed, clean. It was and has been ever since. So, too, is my office system, on which I used *Dr. Solomon's Anti-Virus Toolkit*, after removing it from my home system.

The Specifics

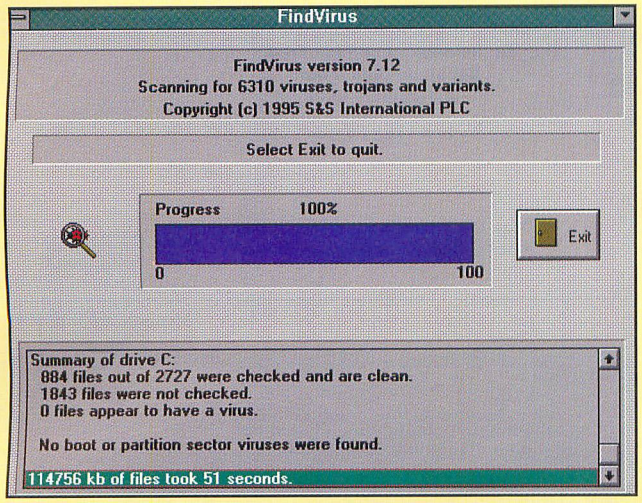
Currently in Version 7.5, *Dr. Solomon's Anti-Virus Toolkit* consists of three 3½" diskettes, a User's Manual, a *Virus Encyclopedia* and a registration card. One diskette is *Windows*-specific and the others are labeled DOS Disk 1 and DOS Disk 2.



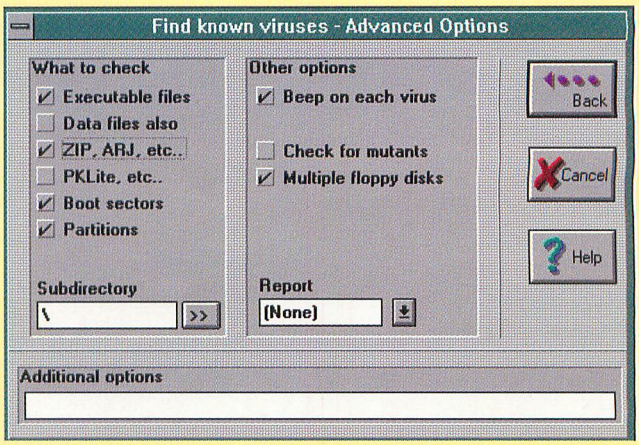
Under *Windows*, launching *Dr. Solomon's Anti-Virus Toolkit* brings up this opening screen (initially overlaid with a progress meter as the program checks system RAM for known viruses). You click on the drive or drives you want to test. All drives in your system, including CD-ROM, are listed. Then you click on either Find or (find and) Repair to initiate the selected action. If you wish, you can also check for changes in your files and call up the on-line *Virus Encyclopedia*.

The User's Manual is a 215-page compendium of facts about viruses in general, installation instructions for the program and a whole lot more. The *Virus Encyclopedia* contains listings of 6,000+ viruses currently in circulation. Since some 150 to 200 new viruses are discovered monthly, according to S&S Software, you can expect that the listings in the *Virus Encyclopedia* to be incomplete almost as soon as this volume is printed. Even so, this volume is a very handy resource to have on hand because it identifies a host of viruses, describes each and how it can affect a system and tells you what can be done to rid a PC of a listed one if it should crop up.

The software is composed of 12 utilities and an on-line *Virus Encyclopedia*. The last is an electronic



Clicking on Find or Repair in the *Toolkit*'s main screen brings up this progress-report screen.



Clicking on Advanced options brings up this screen, in which you can select the types of files to scan. Defaults are already checked. If you wish, you can check one or more of the other selections or even un-check any of the default selections.

version of the included book of the same title, but it's more up-to-date than the printed listings because it contains information up to the moment the diskettes are generated. Utilities included in the *Dr. Solomon's Anti-Virus Toolkit* package are as follows:

- **FindVirus** checks out hard and incoming floppy diskettes and reports on any virus known to the current version of the driver file. Use this utility to scan your hard disks on a daily basis.
- **VirusGuard** is a TSR utility that constantly scans for viruses, identifying known ones and preventing access to any file if a virus is found. (There are a few complex polymorphic viruses that VirusGuard can't prevent from running.) During installation of the software, you can elect to have this utility automatically run in the background at all times when boot-up is complete.
- **ViVerify** detects changes in executable files (those with .EXE, .COM, etc. extensions) that may have been caused by a virus infection. Initially, you can use it to calculate a checksum for each file and then run ViVerify regularly to re-calculate this fingerprint to check for any changes. ViVerify reports on any virus, even a previously undiscovered one.
- **Certify** is a memory-resident checksummer that checks executable files before running or opening them and prevents any attempt to access a changed file.
- **GuardMem** scans physical memory (RAM) and reports the presence of any known memory-resident viruses.
- **Author** marks diskettes with an authorization code, after which you can use VirusGuard to check diskettes for the correct code, as well as viruses. It helps prevent unauthorized diskettes from being used on your PC.
- **Inspect Disk** checks hard and floppy disks for suspect code.
- **Inspect File** checks the contents of a file in ASCII and hexadecimal.
- **Inspect Memory** checks the contents of RAM in ASCII and hexadecimal.
- **CleanBoot** replaces an infected boot sector on a diskette with a non-infected sector.
- **CleanPart** repairs partition sectors and hard-disk boot sectors that have been moved or corrupted by a virus.
- **Shred** deletes files in such a way that they can't be restored by file-recovery programs.

Each of the foregoing utilities can be run as a separate entity. However, for everyday protection, you can set up your system to automatically run VirusGuard on boot-up and switch to the \TOOLKIT directory the program creates during installation and run the TOOLKIT program from there under DOS to perform user-selected tests. Alternatively, if you're working in *Windows*, you can double-click on the *Dr. Solomon's Anti-Virus Toolkit* icon to bring up the *Windows* version of the program and run it from there. In either case, you're given a variety of options from which to choose.

Under DOS, you click on the drive(s) you want to test and then on Find, Repair, Check, Info or Exit to initiate the desired action. Under *Windows*, you select the drive(s) you want to check and then click on Find or Repair to initiate the particular action you wish to take. Still under *Windows*, you also have a choice of Check for Changes and Virus Information. The former uses ViVerify to check your system for changes in executable files, while the latter lets you browse through the on-line *Virus Encyclopedia*.

As you can see in the opening-screen illustration, you also have a choice under *Windows* to bring up the AVTK Toolbar by double-clicking on its icon. When you do this, the Toolbar remains on-screen and ready for access to seven choices by single-clicking on any of its buttons. The choices include: the *Toolkit*; drive A: check; drive B: check; hard drives check; calling up the on-line *Virus Encyclopedia*; launching an Inspect Disk utility; and calling up on-line help. A final button lets you close out the toolbar.

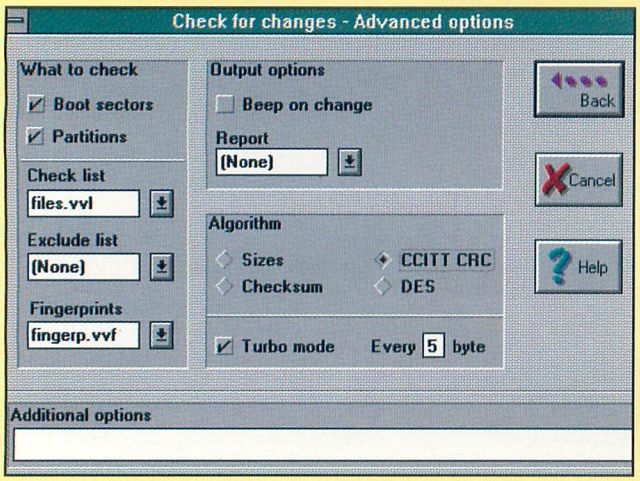
As I write this, the AVTK Toolbar is conveniently positioned along the right side of my screen. (You can move it wherever you wish by clicking on its titlebar and, holding down the left mouse button, dragging it to a new position.) This makes it a snap to refer to and call its button operations without having to exit my word-processing program, taking a look at the selected function, exiting *Dr. Solomon's*, launching my word processor and calling up this file.

Installing the *Toolkit*

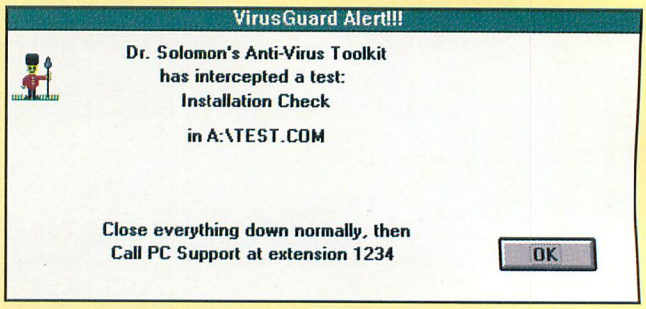
To install the *Dr. Solomon's Anti-Virus Toolkit* program at the DOS level, you place DOS Disk 1 in your drive and then log onto that drive. You then type INSTALL and hit Enter. The program is self-prompting thereafter.

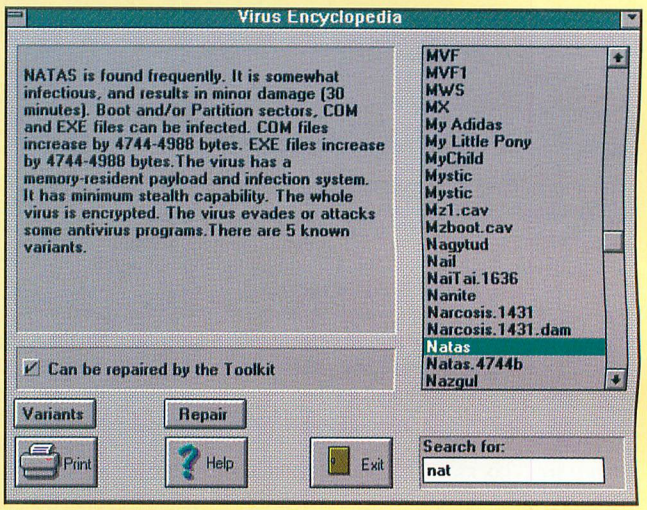
The procedure is just as simple for *Windows* installation, except that you bring up *Windows*, place the *Windows* disk in your drive, click on File, select Run and then type in the source drive and install command, such as A:\SETUP. You're asked for the destination drive and directory for the program (default is C:\TOOLKIT). After SETUP installs the files that are on the *Windows* diskette to your hard drive, you're prompted to replace it with first DOS Disk 1 and then DOS Disk 2, whether or not you installed the *Toolkit* at the DOS level.

During both installations, you're asked if you want to have VirusGuard automatically load during boot-up. Default is Yes. If you're certain that your computer and its hard drives are clean, you can select



(Above left) When you have the *Toolkit* check for changes in files under Advanced options, this screen appears.





(Above right) Whenever you access a floppy disk or CD-ROM that has been infected with a virus, VirusGuard displays this screen and sounds an alert. This screen identifies the source drive of the virus and the name of the infected file.

Calling up the on-line *Virus Encyclopedia* gives an alphabetical listing of all known viruses. Clicking on a virus name gives the particulars about it, including a notice of whether or not the *Toolkit* can repair or remove it. You can then check for variants, print out the details displayed and even launch the Repair utility to clean it out if your system is infected with it. ►

No to have your computer boot up faster—if you don't mind manually checking each floppy disk, CD-ROM and file downloaded from an on-line system or the Internet. I prefer automatic operation to be on the safe side. The extra time it takes during boot-up is insignificant when compared to the security I require.

During installation, you're given three different options from which to choose. If you have a number of PCs to check, you can generate a floppy disk on which you place the required files and use this to analyze and clean the computers. If you have just one PC, your best and safest bet is to install the *Toolkit* at the DOS level or opt for a full *Windows*/DOS installation. Either way, if you reply Yes to having VirusGuard load automatically during boot-up, you get full protection. The User's Manual spells out each option in detail.

When you install *Dr. Solomon's Anti-Virus Toolkit* to your hard disk, you're prompted to enter the level of security you wish. You can choose Maximum, Standard or Minimum security. You can change the level of security at a later time, if you wish.

Maximum security checks all diskettes for boot-sector viruses, all files you copy, all files you write to disk and executable files when you issue instructions to launch them. Maximum security offers the greatest protection, but it also exacts a toll in reducing system performance.

Standard security, which is the default level, checks all diskettes for boot-sector viruses, executable files you copy from your hard disk and diskettes and executable files when you launch them. Unless you really need maximum security, such as if you're goal is to provide maximum protection on a bulletin-board system or on a critical LAN, this is the recommended level because it provides reasonable protection with only a small hit on system performance.

Minimum security checks all diskettes for boot-sector viruses, executable files you copy from diskettes and executable files when you run them. Selecting Minimum security exacts a barely-discernible hit on system performance, while providing a reliable measure of protection.

In all cases, the VirusGuard utility checks files with .APP, .BIN, .COM, .DLL, .EXE, .OVL, .OVR, .SCR, .SYS and .XTP extensions. If you're using *Windows*, you can also optionally check the .FON (font) extension, which can also be infected by viruses. In one form or another, these are all executable files, which are the type viruses generally attack, leaving other types alone.

Using the *Toolkit*

Using *Dr. Solomon's Anti-Virus Toolkit* is a no-brainer. Once you're into either the DOS or the *Windows* version of the program, everything is so self-explanatory that you don't even need the manual—or the *Virus Encyclopedia*, for that matter—to accomplish what you want to do.

If you're operating under DOS and want to check out your system and disk drives, simply log onto the drive on which you installed the program and switch to the \TOOLKIT directory. Type TOOLKIT and hit Enter, and you're ready to go. Under *Windows*, the procedure is even simpler. You just double-click on the *Toolkit* icon, and you're in.

Whether you're operating under DOS or *Windows*, *Dr. Solomon's Anti-Virus Toolkit* puts at your fingertips a powerful weapon to combat viruses. Using the *Toolkit* at its most basic level is sufficient to keep your system from being clobbered by viruses written by idiots who have nothing better to do than to cause other people grief. By having at your disposal advanced features you can incorporate into your daily computing routine, you can exact an extra measure of protection.

Dr. Solomon's Anti-Virus Toolkit isn't just another program designed to guard against virus infections. It's really a whole lot more. When you launch the program, it checks for more than 6,000 (in Version 7.12, which I have on my office PC, the number is 6310, and as of August 28, Version 7.5 checks for more than 6,700) viruses, Trojans and variants. Using advanced heuristic analysis, it detects, de-

Product Tested

Dr. Solomon's Anti-Virus Toolkit, $125; OS/2 Version, $149; NetWare Version, $1,050 for 10-User Starter Pack
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Tel.: 617-273-7400; fax: 617-273-7474
Requirements: IBM PC/compatible (including XT) computer; DOS 3.1 or later; 360K available RAM; *Windows* 3.x for *Windows* version.

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crypts and eradicates unknown viruses as well. It includes a WinGuard device driver that scans programs before they execute and blocks access to an infected file before a virus inflicts wider damage. It also scan inside compressed files to safeguard executables attached to e-mail, stored on diskette, distributed on CD-ROM and downloaded from on-line services and the Internet.

If you've moved on to *Windows 95*, you'll be gratified to note that *Dr. Solomon's Anti-Virus Toolkit* is compatible with it. It runs under *Win95*, but I must admit that it does so a whole lot slower than it did under *Windows for Workgroups* 3.11, taking about three times longer to check out system RAM but not that much longer to check disks.

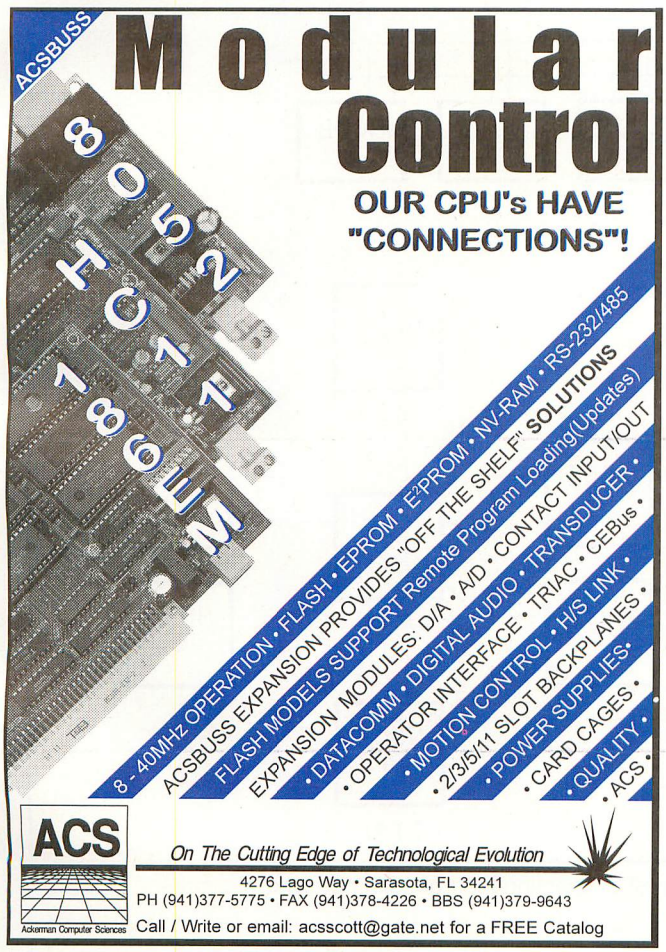
You should be aware that *Dr. Solomon's* wasn't designed for the *Windows 95* environment and won't be effective in combating the viral problems in files specifically written for this operating system. However, by the time you read this, S&S Software should have out on the market or very shortly thereafter (late October) a *Windows 95* version of the *Toolkit* that does address this issue. Considering my experiences with the *Windows* 3.x version of the software, I can't wait to get my hands on the *Win95* version!

User Comment

Dr. Solomon's Anti-Virus Toolkit is everything it's claimed to be. It's effective—in fact, as I mentioned at the beginning of this review, it worked for me when a half-dozen or so other packages failed to perform—and easy to use. It has what it takes to give peace of mind to a skeptic like me in terms of keeping my PC from succumbing to the ravages of viral infection. Having been hit once (it took almost 20 years), I'm a firm believer in anti-virus security.

In this review, I've covered only the basics of the *Dr. Solomon's Anti-Virus Toolkit* package, which should more than suffice for the average user. Space restraints prevent me from covering the more-technical aspects of this terrific program. In fact, from my experiences, I could write a book about computer viruses and what you can do to combat them. But why reinvent the wheel when the book has already been written in the form of the Users Manual that accompanies the *Dr. Solomon's Anti-Virus Toolkit* program?

If you've ever suffered through a bout of computer virus, and its aftermath, you know the value of security. If you haven't and don't have adequate protection against such an event, you may not know just how agonizing the recovery period can be—and you don't want to find out the way I did! Either way, you should rush out right now and buy a reliable anti-virus program and install it immediately. I can't recommend a better purchase than *Dr. Solomon's Anti-Virus Toolkit*. ■



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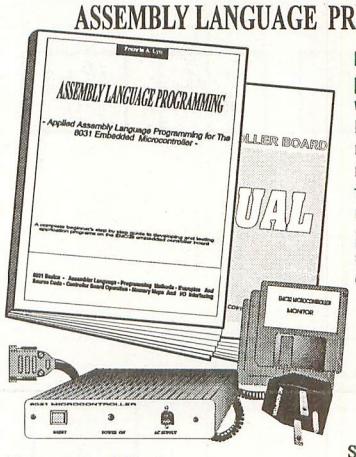

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By Jan Axelson

A Network for Monitoring and Control Purposes

Use this example as a foundation for building networks to suit specific needs

In this article, I present circuits and programming for a network you can use for simple monitoring and control jobs. A master node controls network activities, and up to 32 slave nodes can respond to the master's commands.

In my example network, the master is a personal computer and the slaves are Parallax's Basic Stamp modules. Each slave has five bits you can configure as any combination of inputs and outputs. At the inputs, you can read switch states or any digital outputs or logic levels. The outputs can drive switches, displays or other digital inputs.

Each node connects to the network via an RS-485 serial interface. The distance from the master to the farthest slave node can be as great as 4,000 feet.

This network demonstrates what's involved in putting together and programming a network. It builds on the information about RS-485 links in my article in the July/August issue of *MicroComputer Journal*.

I wrote the example programs in BASIC, mainly because short BASIC programs are easy to write and debug. They make it easy to get the network up and working. BASIC programs aren't the fastest in execution, of course, but they're quick enough for many simple jobs.

The master node's program uses Microsoft's *QuickBasic*. If you want to adapt the code for *Visual Basic*, you'll need to use the Professional Edition's *MSCOMM* custom control or an equivalent for the serial-port functions since the standard edition doesn't include these. The slave nodes use the Stamp's BASIC dialect.

You can use the example network as a base for designing your own projects, with personal computers or microcontrollers of any type, in any

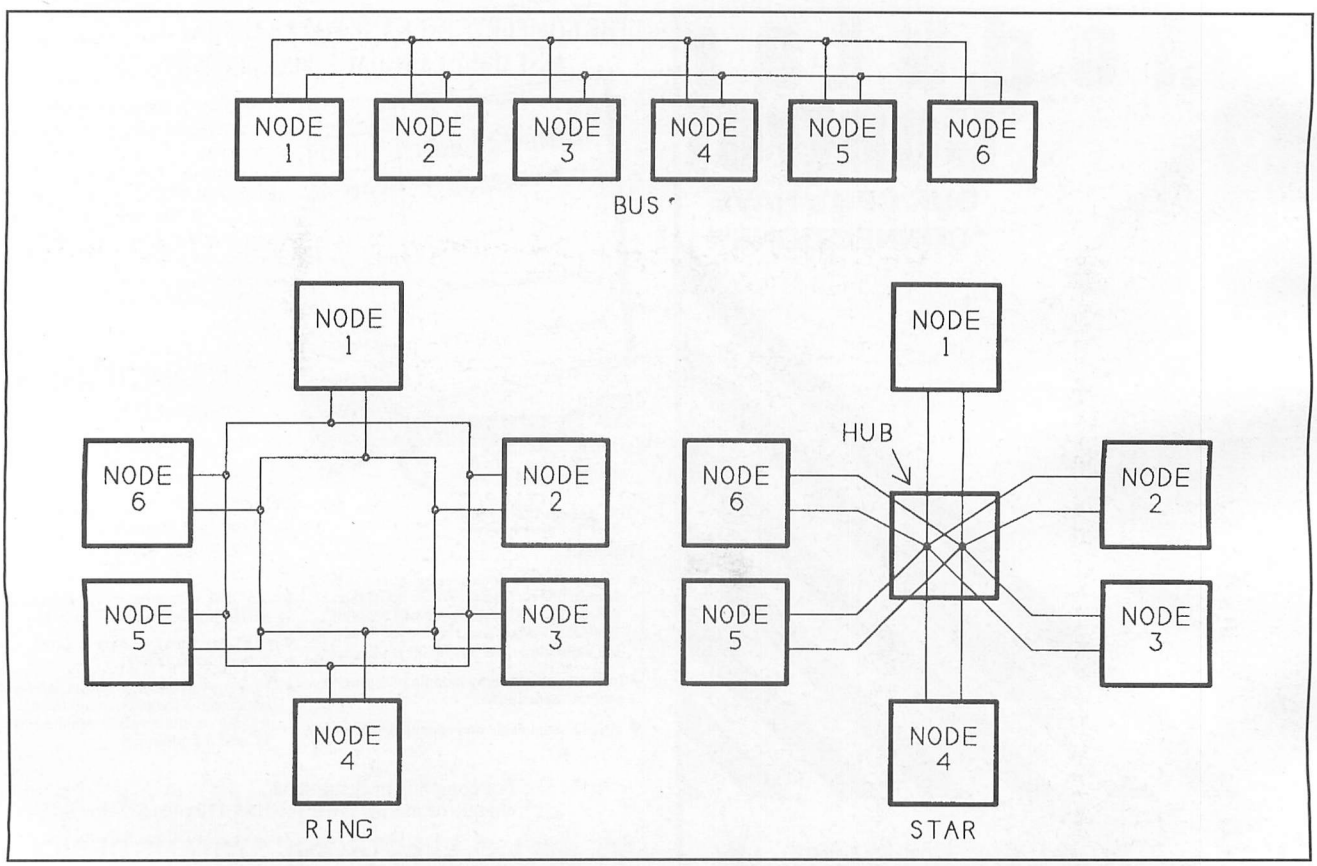

Fig. 1. Bus, ring and star are three network topologies, or ways of connecting the nodes in network.

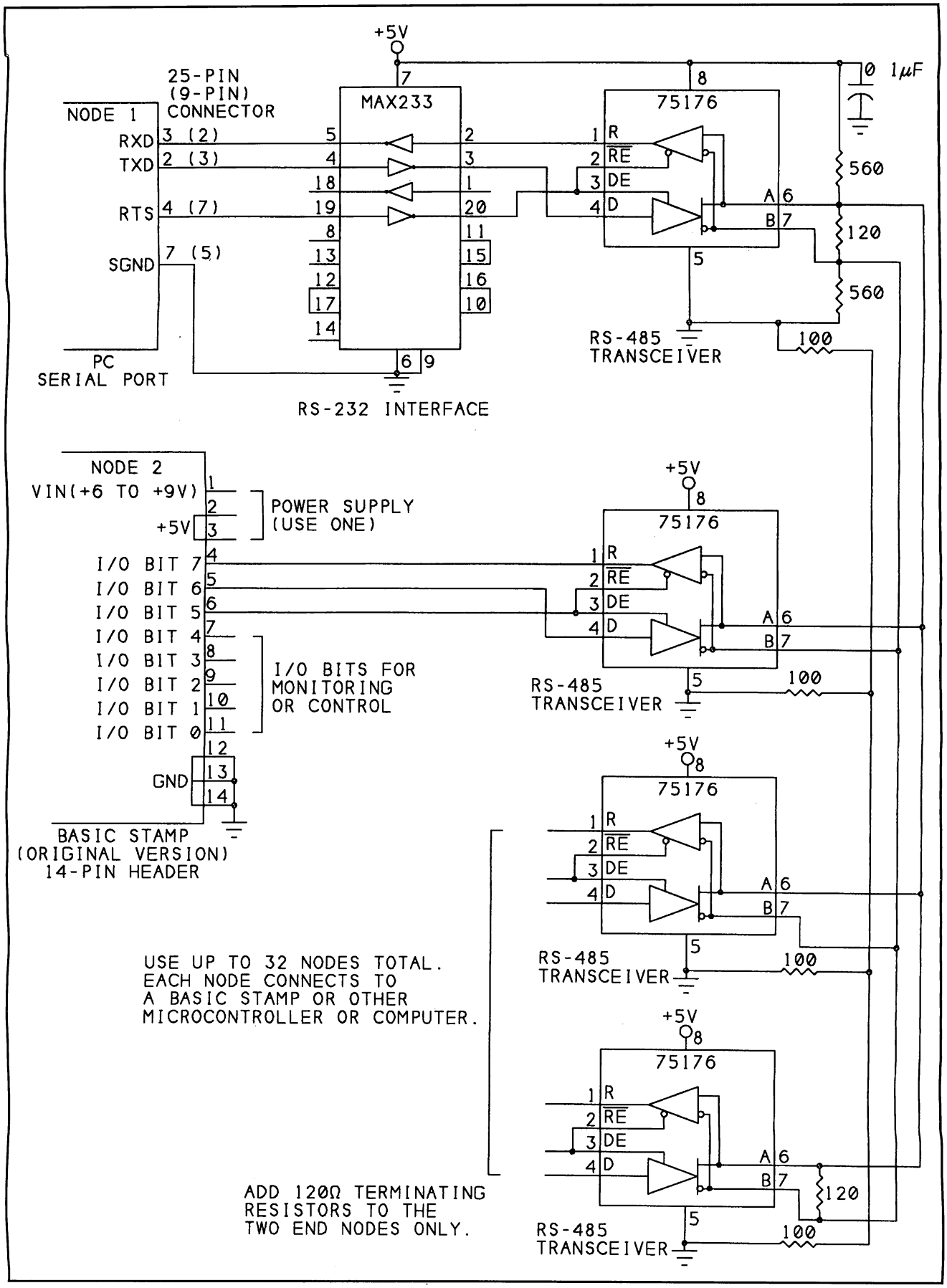

Fig. 2. Connections for a simple RS-485 network using personal computer and Basic Stamps.

combination and any programming language you prefer.

Why Use the Basic Stamp?

If you're not familiar with the Basic Stamp, it's a small (4-square-inch) printed-circuit board that holds a Microchip 16C56 PIC microcontroller with an on-chip BASIC interpreter, along with a serial EEPROM for BASIC program storage. The Stamp's development software runs on a PC and enables you to write a BASIC program, load it into the Stamp's EEPROM, run the program and view the results on-screen. When your program is debugged, you can disconnect the Stamp from the PC, and it will run its program on its own.

I chose Basic Stamps for the network for two reasons. One is that, using the BASIC interpreter and EEPROM storage, you can run your programs immediately after you write them, with no separate compiling or EPROM erasing and programming steps.

The other reason for my choice was that because the Stamp's development software uses a parallel-port connection to a PC, the Stamp's built-in serial port is free for use by the network. In contrast, most other microcontroller development tools—including the 8052's BASIC-52, the 68HC11's BAS11 and most monitor programs—use the microcontroller's serial port to communicate with a PC. This means you can't use the development tools and run your network program simultaneously.

You can always write a program, assemble or compile it, store it in memory on the microcontroller board and then run it. But this isn't as convenient as having the development system up and running at the same time you run the network program. With the Basic Stamp connected to a PC, you can view and edit the Stamp's program code, control program execution and view the results (using debug statements) while you're getting the network going.

The Basic Stamp also has some handy networking abilities built into it. The SER IN statement waits for incoming data at the serial port and automatically stores received data in variables you specify. You can even cause the Stamp to automatically ignore all transmissions except those preceded by a specific number, or qualifier.

Network Configurations

There are many network topologies, or ways to interconnect computers in a network. Illustrated in Fig. 1 are three popular ones: bus, ring and star.

In a bus network, a single set of wires is routed near each node, and short wires (stubs) connect each node to the network. The RS-485 standard assumes bus topology, as does my example network.

In a ring network, instead of the wires ending at the last node, they continue back to the first node, to form a ring. Network traffic travels in only one direction, one node at a time. When a node receives a message, it executes whatever action is appropriate. If the message needs to continue on, the node re-generates the message and passes it to the next node in the ring. Since each node transmits only to its neighbor, the distance around the ring is theoretically unlimited. However, the greater the number of nodes, the longer it will take to pass a message all the way around the ring.

Star topology has a central hub, which may be a computer or just a connecting block. Each node connects to the hub via its own set of wires. An advantage to the star network is that if a connection should open at one of the nodes, transmissions among the other nodes can continue normally.

Of the three topologies, bus usually requires the least amount of wire. This is especially true when the nodes are physically located in a line, one after the other. But the locations of the nodes don't have to determine the topology you use. Even if the nodes are arranged in a ring or star pattern, you can run the network wires as a bus, from one node to the next, ending at the last node.

For large networks, you can create combinations of the basic configurations. For example, each node on a bus might be the hub of a star.

Network Circuits

Shown schematically in Fig. 2 is the circuitry for my example network. All nodes use 75176 RS-485 transceivers to interface to the network. These eight-pin chips convert between 5-volt logic and RS-485's differential signals, with an enable input for each direction of transmission. Because a logic low enables the receiver and a logic high enables the driver, you can tie together the two enables and use one output to control both.

Each node, including the circuits for the master node, requires a 5-volt dc power supply. Since Basic Stamps have on-board voltage regulators, they can use 9-volt batteries or other 6-to-9-volt dc supplies instead of +5 volts. You can use the Stamp's on-board regulated +5-volt output to power other circuits, for up to about 100 mA total output.

Pin functions shown are for the original Stamp. You can use the surface-mount SIP version instead, though the pinout for the SIP is different from that shown.

At the master node, a MAX233 converts the PC's RS-232 output to TTL-level voltages. The MAX233 also re-inverts the RS-232 signals so that at its TTL inputs and outputs, a high voltage is a logic 1 and a low voltage is a logic 0. The TTL voltages interface to the 75176 transceiver.

The serial port's RTS line determines the direction of the 75176. You can control RTS by writing to Bit 1 in the Modem Control Register of the serial port's UART.

Note that the serial cable to the master must have at least four wires. A standard nine-wire cable will have the needed connections, but bear in mind that some serial cables have just three wires.

The Basic Stamp connects directly to its 75176 transceiver. You can use any of the Stamp's eight I/O bits for the serial link. I used Bit 7 as the receive input, Bit 6 as the transmit output and Bit 5 as the direction-control output.

The first and last nodes on the bus each have a 120-ohm termination resistor. Two 560-ohm biasing resistors at one end hold the inputs high when no drivers are enabled on the network.

With three bits of I/O used for the serial link, just five bits of the Basic Stamp's I/O are available for other uses. The Stamp's application notes show how you can accomplish a lot using just a few bits, including a three-line interface to an ADC0831

eight-bit analog-to-digital converter, a way to read a series of switches using one input and the Stamp's Pot instruction and some motor-control circuits and programs.

For the network wires, an unshielded twisted-pair cable works well. Include the ground wire to each node, unless all nodes already have a common signal-ground connection.

Managing Network Traffic

In a full-duplex RS-232 link, you don't have to worry about whose turn it is to "speak." Each driver has its own pair of wires and can transmit whenever it wants.

In a network, you normally have many nodes sharing a single path, and the nodes need a way of deciding when it's okay to transmit. Here again, there are several options in the form of protocols, or sets of rules, for handling the task. Three popular ones are master/slave, token passing and collision detecting.

Master/slave is easy to implement and is what I used in my example network. With this protocol, you designate one node as the master, which controls all network traffic. To ensure that each node has a chance to "speak," the master typically polls, or sends a message to, each of the slaves in sequence. Each poll also usually requests a response from the slave. Slaves are permitted to transmit only when the master requests it.

The main disadvantage to the master/slave protocol is the delays that occur because each node must wait to be polled before it can transmit. Depending on the network's purpose and speed, the delays may be no problem at all or they may be much too long.

For example, imagine a network with a master (Node 1) and nine slaves (Nodes 2 through 10). The master polls each node in sequence, and each poll takes 10 ms. If Node 2 detects an emergency condition and needs to tell the master to take action, it may have to wait as long as 90 ms before the master polls it.

A token-passing protocol eliminates the single master and permits

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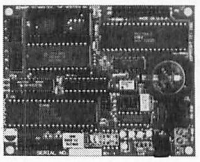

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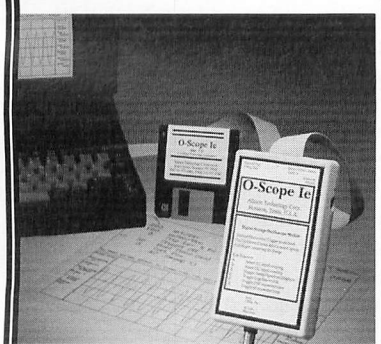

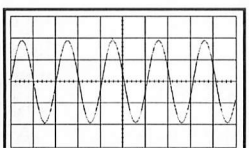
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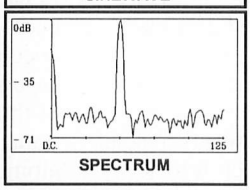

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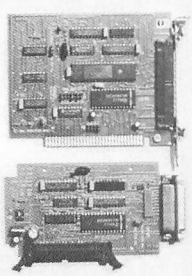

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any node to take control of the network. The node in control is said to have the token. Only one node at a time can have the token.

Network programming must define how a node knows if it has the token, as well as how to pass the token to another node. The token may be just a designated bit or variable that's set or cleared to indicate whether or not a node has the token.

When a node wants to pass the token to another node, it gives up the token it has (by clearing its token-identifying bit, for example) and sends a message that tells another that it now has the token.

With this protocol, you can allow any node that has the token to talk directly to another. But it still doesn't permit a node to interrupt network traffic with an emergency message, unless the node happens to have the token when the emergency occurs.

Collision-detecting protocol permits any node to transmit whenever the transmission path is free. So it's a good choice when any node must be able to transmit when it wants, without delay. But programming for this is much more involved because each node must be able to detect and respond to the inevitable collisions that occur when two or more nodes attempt to transmit simultaneously.

One way a transmitting node can respond to a collision is to wait a random amount of time and then try again. This way, unless many nodes are attempting to transmit at once, a node should be able to get through by the second or third try. The other nodes also must be able to recognize the collisions and ignore the failed attempts at transmitting.

Programming Issues

Even in a simple master/slave network, you must make sure all messages get to their intended destinations without errors and each node responds to only those messages intended for it. For example, assume that Node 1, the master, wants to send a message to Node 2 to tell it to set high output port Bits 2, 3 and 4 and to send back the logic states of input port Bits 0 and 1. All of the following must take place:

- The master must transmit the number of the node it wants to "talk" to and the message and then disable its network driver and wait for a response.
- The slave being addressed must read the incoming data, recognize its number, read the message that follows and recognize when the message has ended. It then must take the requested action at Bits 2, 3 and 4; read Bits 0 and 1; prepare its response; enable its network driver; send the response; and disable its driver when it's finished transmitting.
- The master then reads the incoming response, takes any required action and enables its driver in preparation for polling the next node.
- At the same time, the other slave nodes must monitor the network traffic, recognize that the messages aren't for them and ignore them.

Along the way, there are plenty of opportunities for errors to creep in. The network program should deal with these as best as it can. When it detects a problem, it should first attempt to correct it, if possible. If this fails, the network should display a message, sound an alarm or do something to notify the human operators of the problem and then continue to operate as fully as possible.

For example, if one node doesn't respond for some reason, or if it sends a response the master can't understand, the master should try again. After a number of tries, however, it should know enough to skip the node for the time being, display an error message and move on.

It's also a good idea to use some type of error-checking or acknowledgment with every transmission, in case something becomes garbled along the way. One simple way to do this is to send each message twice and have the receiving end verify that it's the same both times. Of course, this means that each message will take twice as long to transmit.

Another error-checking method is to use a checksum calculated by both ends. A typical way to calculate the checksum is to add all bytes in a message and then use the lowest eight bits of the sum as the checksum. The transmitting end sends the checksum along with the message. The receiving end repeats the calculation. If it obtains a different result, it knows that it didn't receive the same data that was sent. Since the checksum is typically just one byte, it doesn't add much to the length of the message, even when a message is very long.

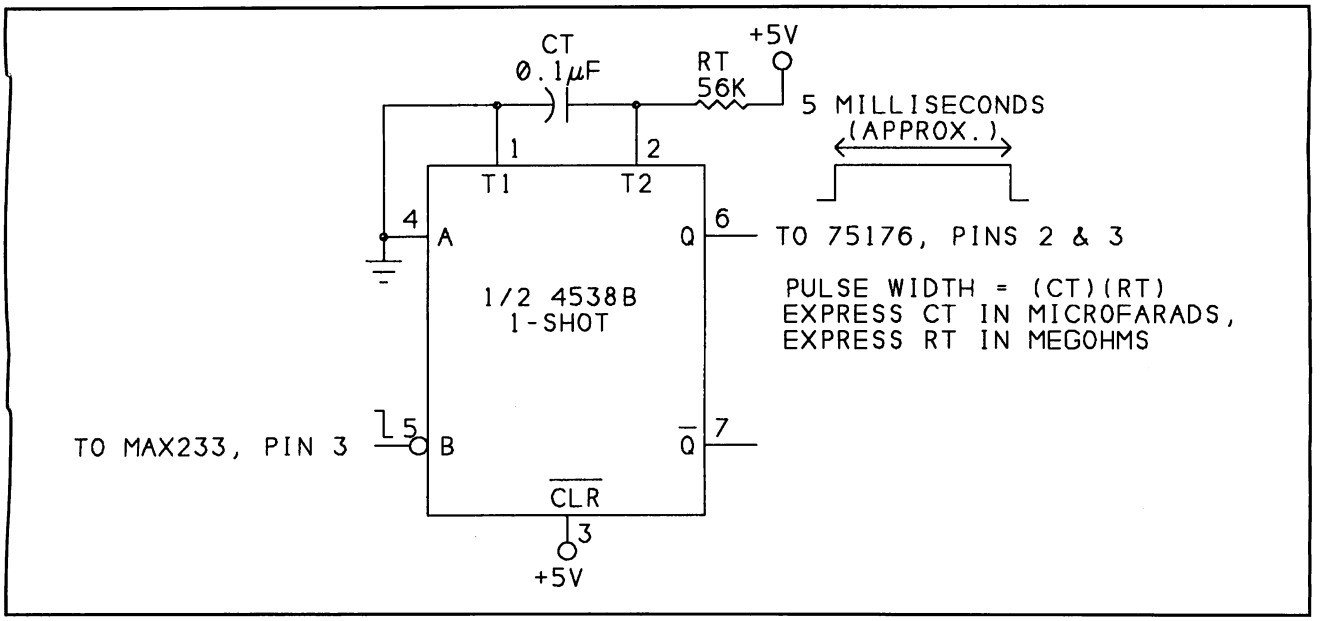


Fig. 3. You can use a one-shot like this to automatically enable an RS-485 driver when a node transmits.

The receiving node also has to be able to detect when a message is finished. One way to do this is to have every message a fixed length, whether it's two or 2,000 bytes. But this isn't efficient if the amount of information to send will vary.

Another approach is to include the message length in a header, which is a defined location at the beginning of the message. The receiving end can then read the length, count the bytes as they arrive and, when the number of bytes received equals the announced message length, it will know that it has received the entire message.

The receiving node should know what to do if a message is shorter than expected. Instead of waiting forever for a message to finish, it should eventually time out and request the master to re-transmit. Also, if this doesn't work after a few tries, the master should know enough to announce the problem and move on. Otherwise, the network will hang in an endless wait.

Direction Control

Another source of error in network transmissions is in the timing of the switching of the drivers and receivers at each end. When a master requests a response, before the slave sends it, the master must disable its driver and enable its receiver, and the slave must do the reverse. If a transmitting node disables its driver before the entire message has transmitted, or if the slave begins to respond before both ends have switched, the message won't get through correctly.

There are several ways to ensure that the timing is correct. The simplest, though not the most-efficient, solution is to add delays in the network programming.

After the master transmits, the program should delay long enough to ensure that the serial port has had enough time to send the entire message. At 2,400 bps, a byte with one stop and one start bit takes a little over 4 ms.

After the slave receives a message, it should wait at least as long as 4 ms, plus a little more, before it enables its driver, to ensure that two drivers aren't enabled at the same time. RS-485 drivers have current-limiting or thermal-shutdown circuits that protect the drivers if they short together, but it's still best to avoid the situation if at all possible.

In a similar manner, after the slave transmits, it should delay a bit before it disables its driver, and the master should delay at least as long before it re-enables its driver to prepare for the next transmission.

Of course all of these delays, and the margin of error you have to build

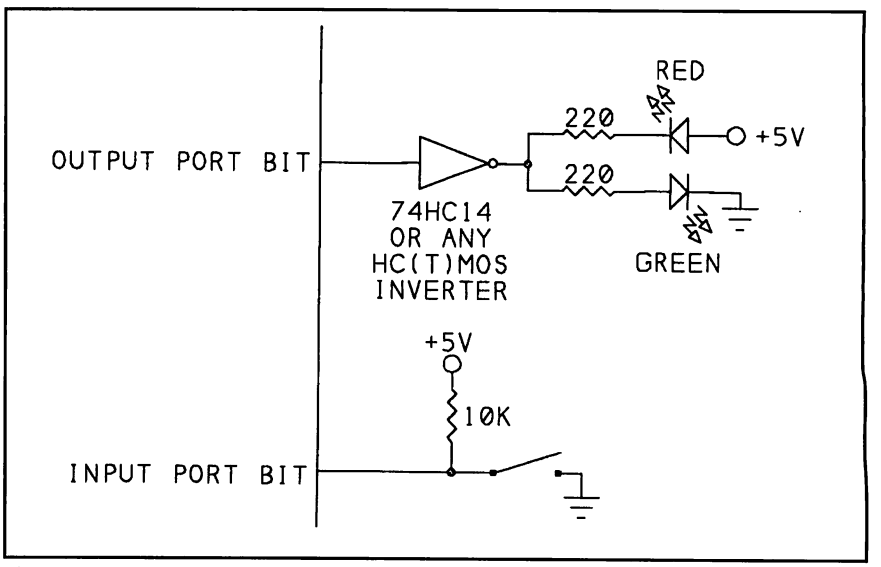


Fig. 4. For basic tests, you can use LEDs as output bits and any slide or toggle switches at input bits.

Listing 1. Simple RS-485 Network

```
SendAMessage:
MSR = INP(MSRAddress)
MSR = MSR AND &HFD                    'set RS=0 to enable the network driver
OUT (MSRAddress), MSR
FOR I = 1 TO 100: NEXT I              'short delay to allow hardware to respond
PRINT #1, CHR$(Node);                 'first, send the node number
FOR I = 1 TO 2000: NEXT I             'delay to allow the byte time to transmit
PRINT #1, CHR$(TestData);             'next, send the test data
PRINT "Writing ", HEX$(TestData), " to node ", Node - &H80
FOR I = 1 TO 2000: NEXT I             'delay to allow the byte time to transmit
RETURN

ReadResponse:
MSR = INP(MSRAddress)
MSR = MSR OR 2                        'set RTS=1 to enable the network receiver
OUT (MSRAddress), MSR
FOR I = 1 TO 100: NEXT I              'short delay to allow hardware to respond
ON COM(ComPort) GOSUB ReadSerialPort 'When data arrives, read it
COM(ComPort) ON                       'BASIC now checks the COM port for received
                                      'data after executing each statement

PRINT "waiting for response..."
ON TIMER(WaitTime) GOSUB TimeOut      'If a node doesn't respond in (WaitTime)
                                      'seconds, display error message & move on
                                      'to the next node
TIMER ON

DO                                    'wait for slave's response
LOOP UNTIL (ResponseReceived = 1) OR (TimeOutFlag = 1)

IF ResponseReceived = 1 THEN          'when the slave responds,
                                      DataIn = (ASC(RD$))
   AnsweringNode = ((DataIn AND &H60) / &H20)  'extract the node #
   IF (DataIn AND 3) = TestData       'check for errors
   THEN
      PRINT "Data received OK"
      ELSE
      PRINT "Error: Data sent = "; TestData; ", Data received = "; DataIn AND 3
   END IF
'Display the received byte
   PRINT "Byte received from node "; AnsweringNode; " (MSB first):"
   PRINT "      Node #            Data Received  Confirm Data Sent"
   PRINT " ________________      ________________      ________"
   FOR Bit = 7 TO 0 STEP -1
      PRINT (DataIn AND 2 ^ Bit) / 2 ^ Bit; "    "
   NEXT Bit
   PRINT
END IF
RETURN

ReadSerialPort:
RD$ = INPUT$(LOC(1), #1)              'read the serial-input buffer
TIMER OFF
ResponseReceived = 1                  'tells main program that the node responded
RETURN

TimeOut:
TIMER OFF
TimeOutFlag = 1                       'tells the main program that a node hasn't
                                      'responded in the allowed time
PRINT "No response from node "; Node - &H80
RETURN
```

```
'This QuickBasic program shows how a master node can send and receive
'information from up to 4 slave nodes in a simple RS-485 network.
'The master polls each slave in sequence.
'Each polling operation consists of three bytes:
'   (1) Node number (0-3) + 80h.
'       Sent by the master to identify the slave the following byte is for.
'       These are the only bytes where bit 7 = 1.
'   (2) Data (0-3).
'       Sent by the master to tell the slave to set output bits 0 & 1 to match.
'   (3) Response. Sent by the slave to the master:
'       Bits 0,1 = number (0-3) received from the master in previous byte.
'       Bits 2,3,4 = values of input bits 2-4 at the slave.
'       Bits 5,6 = node number (0-3).
'       Bit 7 = 0.
'The master reads the response from the slave, confirms that the node number
'and bits 0 and 1 match the values sent, and displays the byte received.

'Change the following 3 statements as needed for your system's serial port:

ComPort = 1                             'COM Port number
databuffer = &H3F8                      'base address of serial port


'The OPEN statement initializes the selected COM port & sets communications
'parameters: 2400 bps, no parity, 8 data bits, 1 stop bit, no handshaking.
'It also enables the receive-data interrupt.
OPEN "COM1: 2400,n,8,1,bin,rs,cs0,ds0,cd0" FOR RANDOM AS #1

'Additional UART registers used:
MSRAddress = databuffer + 4             'modem status register address
LSRAddress = databuffer + 5             'line-status register address

LSR = INP(LSRAddress)                   'clear any error flags
DataRead = INP(databuffer)              'clear any unread data
WaitTime = 5                            'max # seconds to wait for a response
HighestNode = 3                         '# of nodes in the network - 1 (3 or less)
TIMER OFF
CLS

'This is the main program loop.
'It tests the network by polling each node in sequence,
'sending 0, 1, 2, 3 to each node, and displaying the responses.
'After polling each node, the program pauses until you press a key.

WHILE 1 = 1                             'endless loop
   FOR TestData = 0 TO 3
      FOR Node = &H80 TO HighestNode + &H80
         TimeOutFlag = 0                'set =1 when a node doesn't respond in time
         ResponseReceived = 0           'set =1 when a node responds
         GOSUB SendAMessage             'write to a slave node
         GOSUB ReadResponse             'then read the response
         PRINT "Press any key to continue..."
         PRINT
         DO: LOOP WHILE INKEY$ = ""
      NEXT Node
   NEXT TestData
WEND
END
```

Listing 2. Simple RS-485 Network

```
'Basic Stamp slave program for use with Listing 1.
'When the slave recognizes its node number, it reads the next byte, sets its 'output
bits 0-1 to match the value sent, and sends a byte back to the master.

b1=$81                                  'node number.
                                        'Each node has a unique number (0-3) + 80h.

'I/O designations for the Stamp's 8 port bits:
output 0                                'general-purpose output
output 1                                'general-purpose output
input 2                                 'general-purpose input
input 3                                 'general-purpose input
input 4                                 'general-purpose input
output 5                                'transmit/receive control output
output 6                                'transmit output
input 7                                 'receive input

begin:
low 5 'Enable the receiver, disable the driver
debug "waiting for byte...",cr

serin 7,t2400,(b1),b0                   'wait for byte to arrive at serial port
'The above statement defines these serial input parameters:
   'serial input: pin 7
   'transmission rate: 2400 bps, with no inversion of bits
   'node number: 2
   'storage variable: b0
pause 1                                 'wait 10 millisecs to allow byte to arrive

'When the Stamp receives a byte that matches its node number, it stores the
'next byte received in b0.
debug "received ",$b0,cr

'set or clear bits 0 and 1 to match bits 0 and 1 in the received byte
if bit0=1 then bit0set
if bit0=0 then bit0clear
continue1:
if bit1=1 then bit1set
if bit1=0 then bit1clear
continue2:
```

into them, mean that the network won't be as efficient or as fast as you might like. An alternative is to use a control signal that automatically turns on and off the drivers at the proper times.

At the master node, you might think you can control RTS automatically by enabling RTS handshaking in *Quick Basic*'s OPEN COM statement, but the result is different from what's needed here—it just permanently sets high the RTS output. So you have to control RTS directly in your program.

One solution is to use a one-shot multivibrator that automatically enables the driver whenever the node is transmitting. An example of this is illustrated in Fig. 3. The one-shot uses each transmission's start bit to trigger a pulse that enables the driver. With this method, you don't have to use RTS or another bit to control the 75176's direction.

Each byte that transmits is preceded by a start bit and followed by a stop bit. At pin 3 of the MAX233, the start bit is a logic-low voltage and the stop bit is a logic-high voltage. After transmitting a byte, pin 3 remains high until the next start bit. This means that the transmission of each byte begins with a high-to-low transition.

The one-shot uses this characteristic to detect when a byte begins to transmit. On the falling edge of the start bit, the one-shot's output goes high for a time that's slightly greater than the time needed to transmit a byte. Because the one-shot is re-trigger-able, if another byte begins to transmit before the one-shot times out, the transition at the new byte's start bit will hold high the output until that byte has finished transmitting. Soon after the transmission is complete, the one-shot's output goes low and the driver is disabled.

Because the one-shot re-triggers on every falling edge, the time its output remains high will vary, depending on the data sent. If the byte ends in 10, the falling edge at the transition to 0 will re-trigger the one-shot and result in a longer pulse. But if the byte is FFh (all 1s), the one-shot will trigger on only the falling edge of the start bit and the pulse will be shorter.

Because the answering node should enable its driver only after the previous transmitting node has disabled its driver, it must wait long enough for the one-shot to time out, no matter what data was sent, or twice the minimum pulse width.

For precise control, you can pro-

```
'Create variable b0 to send back to the master:
'Bits 0 & 1 are the values received from the master.
b0=pin2 * 4 + b0                        'Set or clear bits 2-4 in b0,
b0=pin3 * 8 + b0                        'to match input bits 2-4.
b0=pin4 * 16 + b0
b0=b1 - $80 * $20 + b0                  'Set bits 5 & 6 to match the node number,
                                        'Bit 7 = 0.
debug "sending ",$b0,cr
pause 1                                 'wait 10 milliseconds before sending
high 5                                  'Enable the driver, disable the receiver
serout 6,t2400,(b0)                     'send b0 to the master on pin 6,
                                        '2400 bps, no inversion
pause 1                                 'wait 10 millisecs to allow byte to arrive
goto begin

'Subroutines for setting and clearing bits 0 and 1
bit0clear:
low 0
debug "bit0clear ",cr
goto continue1

bit0set:
high 0

debug "bit0set ",cr
goto continue1

bit1set:
high 1
debug "bit1set ",cr
goto continue2

bit1clear:
low 1
debug "bit1clear ",cr
goto continue2
```

gram a microcontroller to enable and disable the RS-485 driver at the appropriate times. R.E. Smith's RSFC-PIC is an example of an RS-232 to RS-485 converter that uses a PIC microcontroller programmed for this purpose. With this approach, you don't have to worry about the delay timing at all, and a node can transmit as soon as it's ready.

Network Programs

Given in Listing 1 is the software code for the master node on the PC, while Listing 2 is the program stored in each Basic Stamp. The Stamp programs must give each node a unique number, or address.

Each Stamp receives each network transmission and compares the node number with its own. When a node recognizes its address, it performs the requested actions and transmits a response. Since the program code includes many comments, I won't repeat the same information here.

The example programs are very simple and perform just a few functions, with minimal error-checking. They're intended as a starting point from which you can design a network for a particular purpose.

Shown in Fig. 4 are input and output circuits you can use for testing a network, with LEDs to display output states and toggle or slide switches to control inputs.

The number of slave nodes is limited to four only because the slave responses are a single byte, with just two bits available for identifying the node. You can have up to 31 slaves if you use fewer I/O bits or have the slaves respond with two or more bytes.

Sources

Basic Stamp
Parallax
3805 Atherton Rd. #102
Rocklin, CA 95765
Tel.: 916-624-8333; fax: 915-624-8003
CIRCLE NO. 151 ON FREE INFORMATION CARD

RS-485 Adapters, Software
RE Smith
4311 Tylersville Rd.
Hamilton, OH 45011
Tel.: 513-874-4796; fax: 513-874-1236
CIRCLE NO. 152 ON FREE INFORMATION CARD

Moving On

Send your comments, questions, suggestions, etc. to me by e-mail at Janaxel@aol.com or by mail to me at Lakeview Research, 2209 Winnebago St., Madison, WI 53704. ■

By Fred Eady

Getting to Know the RS-232 Standard

Origin of the serial-port standard, its evolution and the technical details you need to know to successfully use it

As I was writing this article, I thought about how much I depend upon the RS-232 standard every day. Without the RS-232 interface, you probably wouldn't be able to get to and download text and code from the EDTP BBS and other on-line services. My Internet and CompuServe e-mail simply wouldn't exist. And all of the programmer kits that EDTP produces use an offshoot of the RS-232 standard to communicate with a host personal computer. Would you have been able to use your computer yesterday to fax that special graphic or message? How about those software updates you got from your software vendor's public bulletin board? Could you get along without your daily dose of office e-mail?

If you've ever stopped to think about what really lies behind all of this telecommunication technology, you'll find here the answers that are hidden within the ubiquitous RS-232 standard. I begin at the beginning—the origin of the standard.

Table 1.Specifications List for RS-232 Interface

Pin	Line Label	Line Name	Signal Direction	RS-232 Level
1	AA	Positive Ground	N.A.	A,B,C
2	BA	Transmitted Data	To DCE	A,B,C
3	BB	Received Data	To DTE	A,B,C
4	CA	Request To Send	To DCE	A,B,C
5	CB	Clear To Send	To DTE	A,B,C
6	CC	Data Set Ready	To DTE	A,B,C
7	AB	Signal Ground	N.A.	A,B,C
8	CF	Received Line Signal Detector (RS-232C); Data Carrier Detect (RS-232A/B)	To DTE	A,B,C
11	N.A.	Select Standby	To DCE	C
12	SCF	Secondary Receive Line Signal Detector	To DTE	C
13	SCB	Secondary Clear To Send	To DTE	C
14	SBA	Secondary Transmitted Data	To DCE	C
14	N.A.	New Sync	To DCE	A,B,C
15	DB	Transmitter Signal Element Timing	To DTE	A,B,C
16	SBB	Secondary Received Data	To DTE	C
17	DD	Receiver Signal Element Timing	To DTE	A,B,C
18	N.A.	Test	To DCE	C
19	SCA	Secondary Request To Send	To DCE	C
20	CD	Data Terminal Ready	To DCE	A,B,C
21	CG	Signal Quality Detector	To DTE	C
22	CE	Ring/Calling Indicate	To DTE	A,B,C
23	CH	Data Signal Rate Selector	To DCE	C
23	CI	Data Signal Rate Selector	To DTE	C
24	DA	Transmitter Signal Element Timing	To DCE	A,B,C

Computers Learn to Speak

In the beginning, computers of all sizes (most of them large to very large) communicated via wire pairs that carried pure digital signals. This was commonly termed digital or direct-current signaling. The maximum practical distance data could be transmitted was only about a mile at a speed of only 300 bits per second (bps). This arrangement usually required computer or terminal users to install special cable and locate regenerative repeaters every few thousand feet to obtain reliable data communication. These primitive networks rarely reached beyond the sites on which they were installed.

By current standards, this was a simple but expensive way to ship data packets between computers and users. Even back, then some users saw this system of digital communication as a major drawback for the future of large-scale computing and digital telecommunication as a whole.

The idea to use the public common-carrier system (voice telephone facilities) to send and receive digital data arose. After all, some sort of telephone system was already in place almost everywhere on Earth. The modem—or data set—was pressed into service.

A data set was placed at each computer site for the purpose of modulating and demodulating digital signals that were transmitted between other remote computers over the analog telephone system. This new "*mo*dulation and *demo*dulation" hardware was to become what we now know as the modem.

And Then There Was RS-232

With the advent of the modem, teleprocessing life was good, albeit ex-

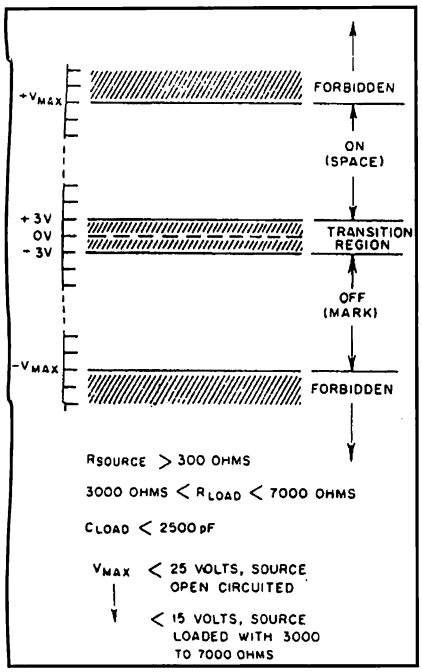


Fig. 1. Minimum and maximum specifications for RS-232D and V.28.

Table 2. Pinout Details For RS-232 Interface Using 25-Pin Connector

Pin	Label	Name
1	AA	Protective Ground
2	BA	Transmitted Data
3	BB	Received Data
4	CA	Request To Send
5	CB	Clear To Send
6	CC	Data Set Ready
7	AB	Signal Common
8	CF	Received Line Signal Detect
9	N.A.	Reserved For Testing
10	N.A.	Reserved For Testing
11	N.A.	Unassigned
12	SCF	Secondary Received Line Signal Detect
13	SCB	Secondary Clear To Send
14	SBA	Secondary Transmitted Data
15	DB	Transmission Signal Element Timing
16	SBB	Secondary Received Data
17	DD	Receiver Signal Element Timing
18	N.A.	Unassigned
19	SCA	Secondary Request To Send
20	CD	Data Terminal Ready
21	CG	Signal Quality Detector
22	CE	Ring Indicator
23	CH/CI	Data Signal Rate Detector
24	DA	Transmit Signal Element Timing
25	N.A.	Unassigned

pensive, and everyone was making modems. In May of 1960, it was evident that a standard was needed to identify the electrical interface between computer and modem or data set. It was decided to establish a standard voltage with standard signal parameters and a standard nomenclature to identify the conductors in the cable

Table 3. Minimum Pinout Details to Achieve DTE-to-DCE Communication Using 25-Pin Interface Connector

Pin	Label	Name
1	N.A.–	Protective Ground
2	TD	Transmitted Data
3	RD	Received Data
4	RTS	Request To Send
5	CTS	Clear To Send
6	DSR	Data Set Ready
7	N.A.	Signal Common
8	DCD	Data Carrier Detect
20	DTR	Data Terminal Ready
22	RI	Ring Indicator
23	DSRD	Data Signal Rate Detector

Table 4. Pinout Details of RS-232 Pseudo-Standard Nine-Pin Interface

Pin	Label	Name
1	DCD	Data Carrier Detect
2	RD	Received Data
3	TD	Transmitted Data
4	DTR	Data Terminal Ready
5	–	Signal Common
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

that connected computer and modem.

Teleprocessing technology was booming, and more and more computers and terminals built by various vendors needed to communicate with each other. Without a standard, the whole teleprocessing industry could come to a grinding, non-standardized halt.

As a result, a committee named the Electronic Industries Association was formed. The EIA drafted a standard known as EIA RS-232(X). Though it was a great idea, the original specification was broad in meaning and didn't guarantee compatibility. (The new RS-232 specification also had a competitor outside the United States, known as the CCITT, or Consultative Committee for International Telephone and Telegraph, Recommendation V.24).

The RS-232 proposal defined a logical and physical interface between computer equipment and a modem. Basically, two interfaces are really needed to complete digital communication between a pair of computers and/or terminals.

The computer or terminal port presents both a physical and a logical interface to the modem and consists of several conductors for controlling, transmitting and receiving data, and timing/clocking. For this discussion, the interface between computer and modem has a set of standards and s referred to as an EIA RS-232 interface.

The second interface provides the modem with a physical path to the communication channel (telephone line, fiber-optic link, satellite, etc.). For most personal-computer users, this communication channel is the two-conductor analog telephone line.

The EIA standard originally identified seven interface conductors and no specific connector. Signal voltages were defined as at least ±3 volts but not greater than 20 volts with respect to ground.

In October 1963, RS-232 became RS-232-A and was modified to include a 25-pin connector with a maximum cable length of 50 feet. This revision established fixed relationships between a circuit and specific pin numbers. Also, an alphabetic coding system for each type of interface circuit was presented. The first character of the coding system designated A for ground, B for data, C for control and D for clocking.

The original seven basic circuits and the signal-level definition of –3 for mark and +3 for space were retained intact, adding ten additional optional circuit definitions. The maximum permissible open-circuit voltage was changed to 25 volts, and a current maximum between any two conductors, including ground, was set at 0.5 ampere. Conductors that permit auto-answer capability were first introduced in this revision.

October 1965 brought about RS-232-B, which defined terminating impedances that permitted circuit designers to build hardware with greater reliability. Open-circuit signal levels remained unchanged at –3 to –25 volts as mark and +3 to +25 volts as space, but revision B added an important voltage specification. By specifying that signal ground on pin 7 be tied to frame ground on pin 1 in the modem, a definite signal reference is established between modem and host computer or terminal.

This "Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange" specification was released in August 1969. It further clarified conductor definitions and

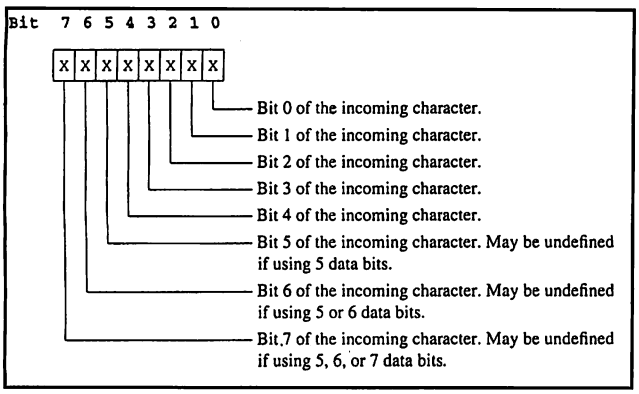


Fig. 2. Receiver Buffer Register.

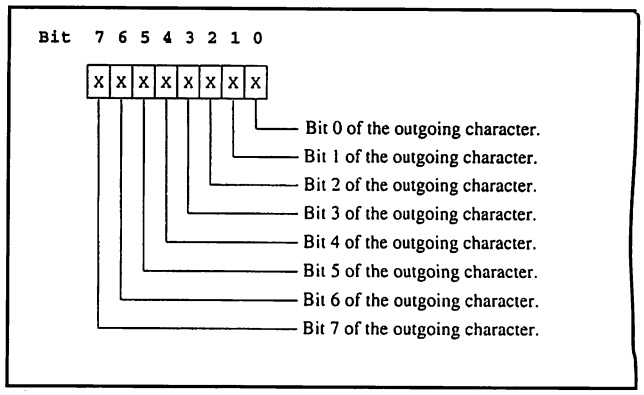


Fig. 3. Transmitter Holding Register.

stated that properly-terminated RS-232 circuits shall not exceed ±15 volts.

RS-232-C came along later and defined the interface between Data Terminal Equipment (DTE) and Data Circuit terminating Equipment (DCE). DTE equipment is normally a dumb terminal, intelligent device like a microcontroller or intelligent workstation like a PC that's capable of providing a serial bit stream. DCE equipment receives the DTE-generated bit stream via the RS-232 interface and converts it to a form that's suitable for transmission over a telecommunication medium, such as voice-grade telephone lines.

If the RS-232-C standard is followed, physical DTE port connectors are male and physical DCE port connectors are female. A PC's serial port is normally the DTE device and the modem's port is usually configured as a DCE device.

A PC's serial port is male, whether it uses a nine- or a 25-pin connector. The modem connector is most likely a female 25-pin connector. Although the nine-pin connector isn't an EIA RS-232 standard, today it's a commonly used RS-232 physical interface. The nine-pin interface first appeared commercially on AT-class PCs in the early 1980s.

RS-232-C also provided specifications for communication over voice-grade lines, at speeds up to 9,600 bps. This allowed for high-speed asynchronous point-to-point communication over the public switched telephone network at that time.

RS-232-C defines 21 circuits on the interface. Table 1 is a summary of the RS-232-A, -B and -C pin descriptions.

During data transmission, the mark condition denotes the binary-1 state and the space condition denotes the binary-0 state.

For timing and control interchange circuits, the function shall be considered ON when the voltage is more-positive than +3 volts and shall be considered OFF when the voltage is more-negative than –3 volts, both with respect to signal ground. The function isn't defined if the voltages are within the transition region between –3 to +3 volts with respect to signal ground.

Mark and space are commonly used in specification sheets to describe the condition of an RS-232 data or control line. Figure 1 defines the minimums and maximums of the RS-232-D and V.28 specifications and as some of the termination specifications.

Today, the majority of commercially available equipment is based on the RS-232-C or RS-232-D standard. (The CCITT V.24 and V.28 standards are also common and widely used.) Many of the RS-232 circuits don't have to be used to in a communication session between two terminals or computers. Refer to Tables 2 and 3 as I describe the purpose of the most commonly used RS-232 data interface connections.

RS-232 Circuit Description

The first thing you'll notice is that Table 3 lists only 11 of the 25 possible RS-232 lines as those required to complete a DTE-to-DCE communications session. In most cases, you can also omit the Data Signal Rate Detector and Protective Ground circuits. This leaves nine connections.

Remember that RS-232 is a standard interface specification and can be used for a variety of other purposes, such as synchronous communication and protocols that require additional clocking and timing. In reality, you can have a working DTE-to-DCE conversation using only three of the 11 lines shown in Table 3. If the DTE and DCE utilize custom-written software, only TD, RD and signal ground are required to move data along the three-conductor link.

Here's a rundown of the definitions of the 11 pins that almost everybody uses:

- **Pin 1** (Protective Ground Circuit, AA). This conductor is bonded to the equipment frame and can be connected to external grounds if other regulations or applications require it.
- **Pin 2** (Transmitted Data Circuit BA, TD). This is the data signal generated by the DTE. The serial bit stream from this pin is the data that's ultimately transmitted by the modem or decoded by an intelligent DCE device.
- **Pin 3** (Received Data Circuit BB, RD). Signals on this circuit are generated by the DCE. The serial bit stream originated at the remote DTE and is a product of the receive circuitry of the DCE. This is usually digital data that's produced by an intelligent DCE or modem demodulator circuitry.
- **Pin 4** (Request To Send Circuit CA, RTS). This signal prepares the DCE for a transmit operation. The RTS ON condition puts the DCE in transmit mode, while the OFF condition places the DCE in receive mode. The DCE should respond to an RTS ON by turning ON Clear to Send (CTS). Once RTS is turned OFF, it shouldn't be turned ON again until CTS has been turned OFF. This signal is used in conjunction with DTR, DSR and DCD. RTS is used extensively in flow control.
- **Pin 5** (Clear To Send Circuit CB,

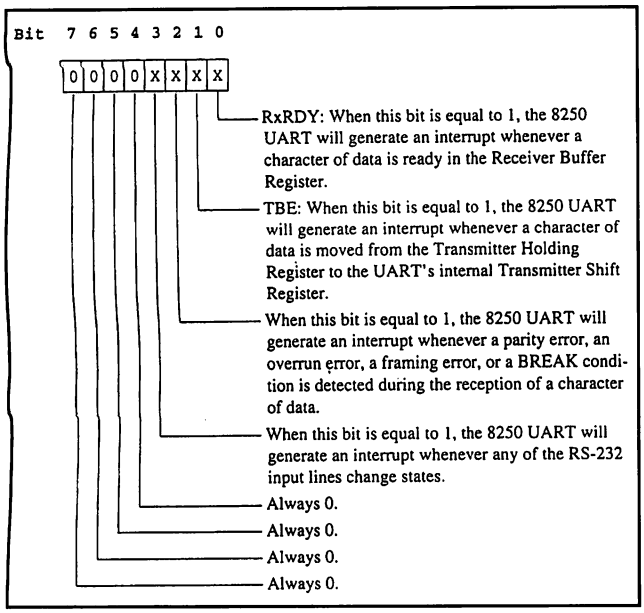
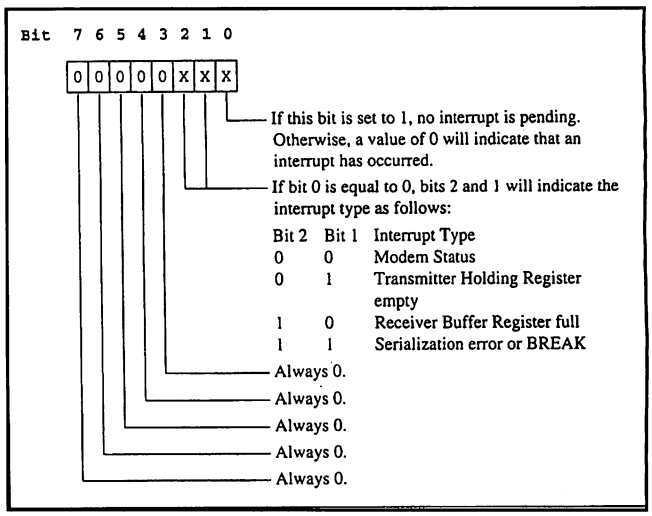


Fig. 4. Interrupt-Enable Register.

Fig. 5. Interrupt-Identification Register for 8250.



CTS). This signal acknowledges the DTE when RTS has been sensed and data can be transmitted. Data is transmitted across the communications medium only when this signal is active. This signal is used in conjunction with DTR, DSR and DCD. CTS is used in conjunction with RTS for flow control.

• **Pin 6** (Data Set Ready Circuit CC, DSR). DSR indicates to the DTE that the DCE equipment is connected to a valid communication medium and, in some cases, indicates that the line is in the OFF HOOK condition. OFF HOOK is an indication that the DCE is either in dialing mode or in session with another remote DCE. When this signal is OFF, the DTE should be instructed to ignore all other DCE signals. If this signal is turned off before DTR, the DTE is to assume an aborted communication session.

• **Pin 7** (Signal Common Circuit, AB). This conductor establishes the common-ground reference for all interchange circuits, except Circuit AA, protective ground. The RS-232-B specification permits this circuit to be optionally connected to protective ground within the DCE as necessary.

• **Pin 8** (Data Carrier Detect Circuit CF, DCD). This pin is also known as Received Line Signal Detect (RSLD) or Carrier Detect (CD). This signal is active when a suitable carrier is established between the local and remote DCE devices. When this signal is OFF, RD should be clamped to the mark state (binary 1).

• **Pin 20** (Data Terminal Ready Circuit CD, DTR). DTR signals are used to control switching of the DCE to the communication medium. DTR ON indicates to the DCE that connections in progress shall remain in progress, and if no sessions are in progress, new connections can be made. DTR is normally turned off to initiate ON HOOK (hang-up) conditions. The normal DCE response to activating DTR is to activate DSR.

• **Pin 22** (Ring Indicator Circuit CE, RI). The ON condition of this signal indicates that a ring signal is being received from the communication medium (telephone line). It's normally up to the control program to act on the presence of this signal.

• **Pin 23** (Data Signal Rate Detector Circuit CH/CI, DSRD). Circuit CH is the DTE component, CI the DCE component. Signals on this circuit are used to select between the two data-signaling rates in the case of dual-rate modems. ON selects the greater of the two rates.

(1) DTE is powered up and DTR is asserted.

(2) DCE is powered up and senses the DTR from the DTE.

(3) DCE asserts DSR. The modem goes off-hook.

(4) If the line is good and the other end is ready, the carrier is detected and the DCE asserts DCD.

(5) The DTE raises RTS.

(6) The DCE responds with CTS.

(7) The communication session is established. The control program transmits or receives data.

A typical answer sequence would go something like this:

(1) The DTE has the DTR asserted.

(2) The DCE is in auto-answer mode, with DSR asserted.

(3) The remote station calls DCE emits RI.

(4) The DTE senses RI. The control program takes control. The DCE goes off-hook.

(5) The DCE negotiates with the remote DCE, and DCD is asserted.

(6) Depending upon the control program, RTS is asserted or the DTE waits for data.

(7) The DCE responds with CTS.

(8) The communication session is established.

In the early days, half-duplex communication dominated, mainly because of the communication protocols and hardware that existed at that time. In half-duplex, data can travel in only one direction at any given time. For instance, on a two-conductor telephone line, one computer would transmit while the other received and *vice-versa*. In combination with the hardware, the half-duplex software protocol determined which end was to receive or transmit.

Full-duplex protocol permits transmission and reception without regard to who is talking and who is listening at any given time. To achieve full-duplex operation required two pair of telephone conductors, one pair each for transmit and receive. Of course, the transmit pair at the local end was connected to the receive pair at the

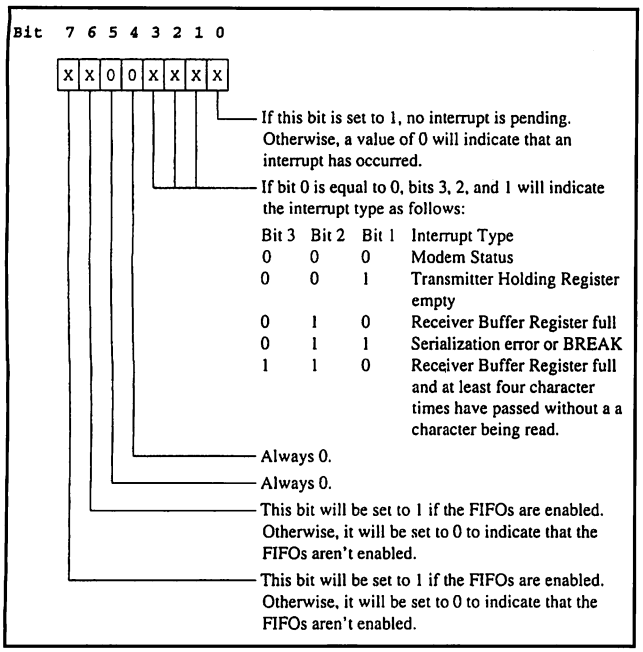


Fig. 6. Interrupt-Identification Register for 16550.

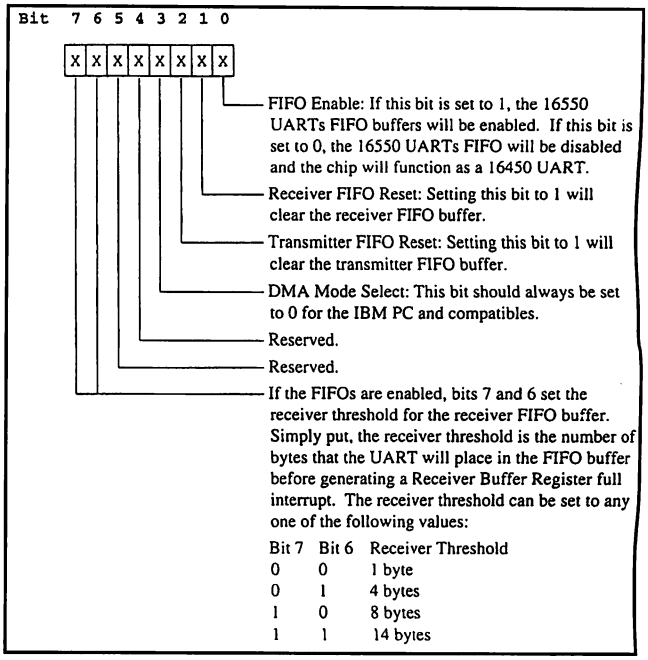


Fig. 7. FIFO Control Register.

remote end and the local receive pair was connected to the remote transmit pair.

Two-conductor half-duplex and four-conductor full-duplex implementations remain even today, but two-conductor full-duplex communication is now the norm. Full-duplex two-conductor communication is the child of advanced frequency- and phase-modulation techniques contained in modern modems.

Table 4 details the pseudo-standard AT nine-pin interface.

Asynchronous Data Packet

Assuming you have RS-232 standards

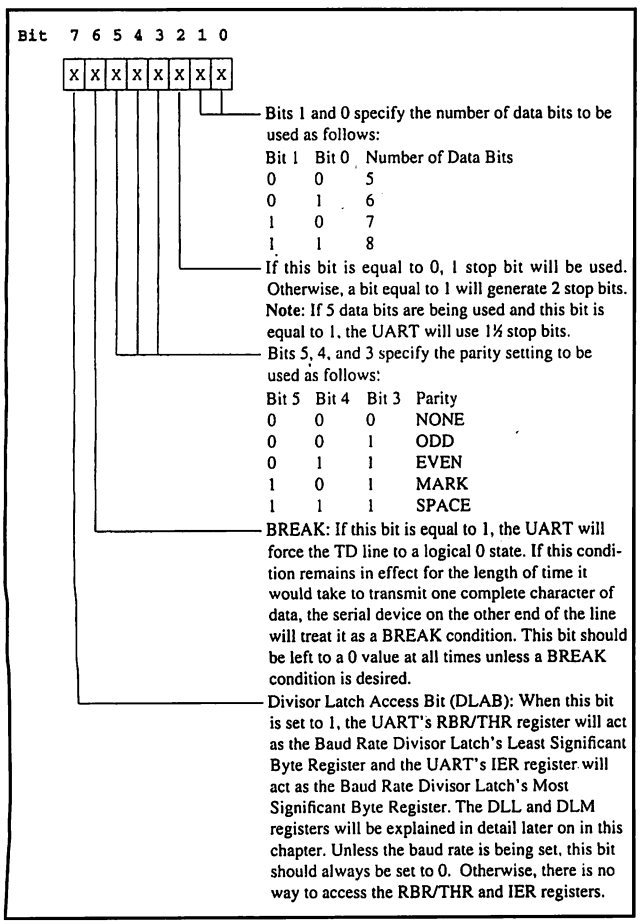
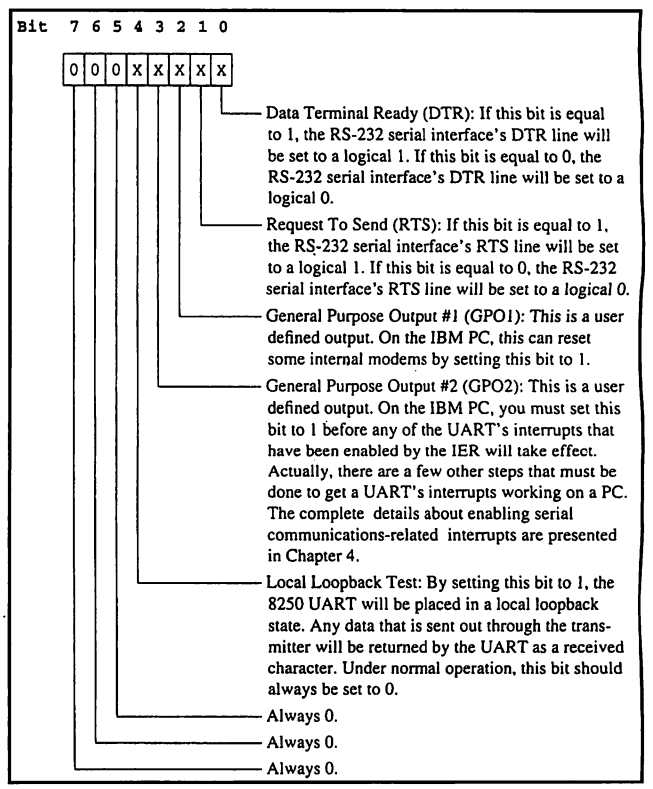


Fig. 8. Line-Control Register for 16550.

Fig. 9. Modem-Control Register.



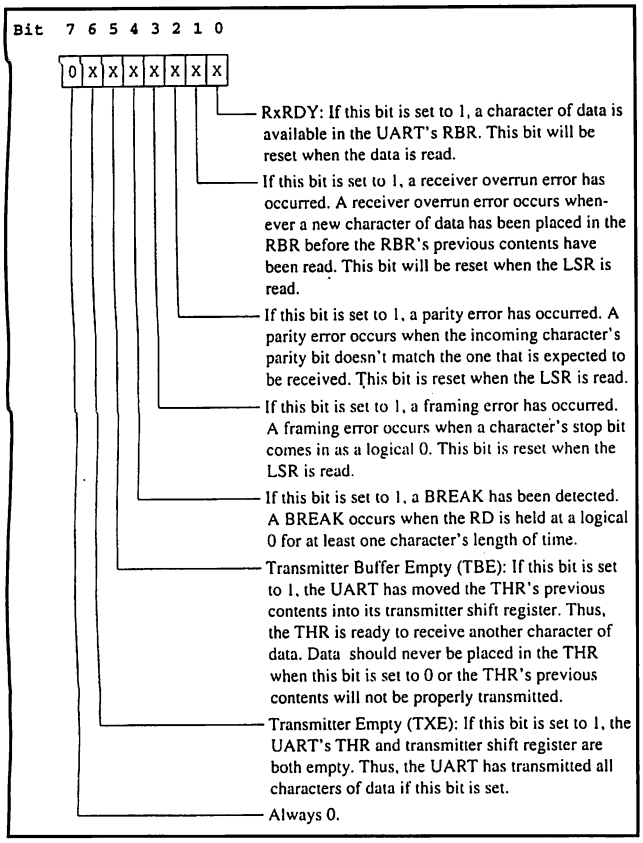


Fig. 10. Line-Status Register for 8250.

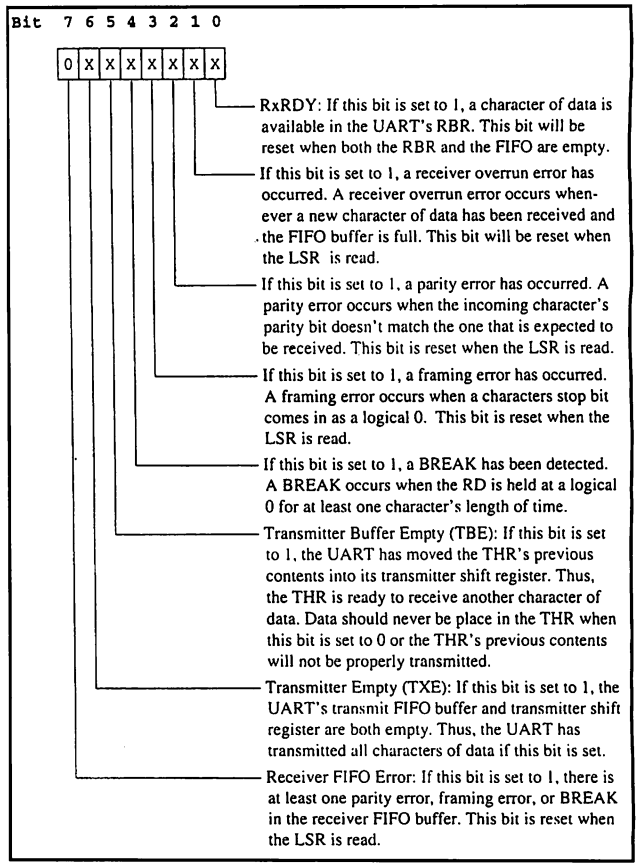


Fig. 11. Line-status register for 16550.

implemented, four other parameters are important to obtaining a successful asynchronous communication session. These are baud rate, number of data bits, number of stop bits and parity bit. If necessary, a parity bit can be added. However, for simplicity, most asynchronous links don't use one. Parity is primarily used to help ensure data integrity on critical links. The downside to parity is that if your data packet gets trashed, you won't recover the data, no matter what parity scheme you have in place.

A typical transmitted packet of data consists of a start bit, eight data bits and a stop bit. The other most-common combination is seven data bits with even parity and one stop bit.

The width of each bit determines the baud rate. For example, for a 9,600-bps link, each bit width is 104 µs, arrived at by equating 9,600 to frequency and 104 µs to period and applying the formula P = 1/F, where *P* is period in seconds and *F* is frequency in Hz. In advanced protocols, baud rate can also be measured by the number of phase transitions in a given period of time.

In asynchronous serial transmission, first to be transmitted is the start bit. This bit permits the receiving DTE to synchronize with the transmitting DTE. The start bit is a logic 0 space that lasts for exactly one bit period. The link should always be in a mark, or 1, state before the start bit is sent.

Once the receiving DTE senses a start bit, it waits exactly 1.5 bit periods, or 156 µs for 9,600 bps, before sampling the status of the link. The idea is for the receiving DTE to sample each bit frame as close to the center of the timing frame as possible. After the first 1.5-bit period wait, the receiving DTE reverts to sampling the incoming bit stream at the standard 104-µs-per-frame rate. If everything goes as planned, the rest of the data byte will be sampled near the center of each bit time.

A stop bit (mark) signals the end of the character transmission. One or two stop bits are normally used to end a transmission. This entire process—start bit, data, stop bit—repeats itself for every character transmitted, eliminating any probable cumulative timing skew.

8250 & 16550 UARTs

The heart of the serial port is the UART, or Universal Asynchronous Receiver Transmitter. The original personal computers used the INS8250 family of UARTs. Most high-speed RS-232 interfaces today contain the 16550 UART. The 16550 is a high-speed buffered version of the 8250.

Fundamental operations performed by the 8250 and 16550 are almost identical. Serial ports on a PC are named COM1 through COM4. For this discussion, assume all references are relative to COM1 at address 3F8h. These UARTs use a register map to simplify implementing serial algorithms. Let's dissect the 8250 and 16550 register-by-register:

• ***Receiver Buffer Register.*** Figure 2 logically depicts Register 0, which is Receiver Buffer Register, or RBR. When a character is received by the UART, it's assembled and placed in the RBR. This assembled value can be read by performing a read operation at address 3F8. This register is identical to the 16550 RBR.

• ***Transmitter Holding Register.*** This

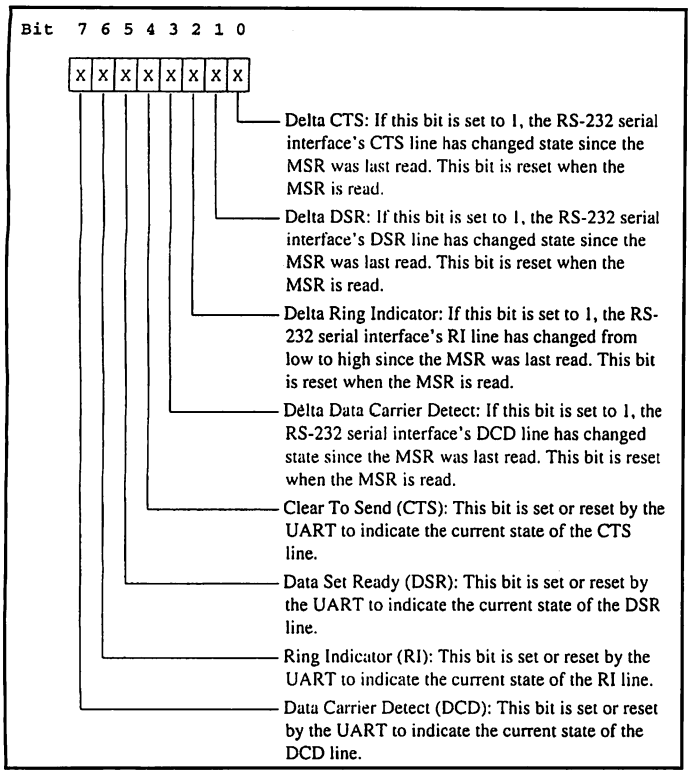


Fig. 12. Modem-Status Register for 8450.

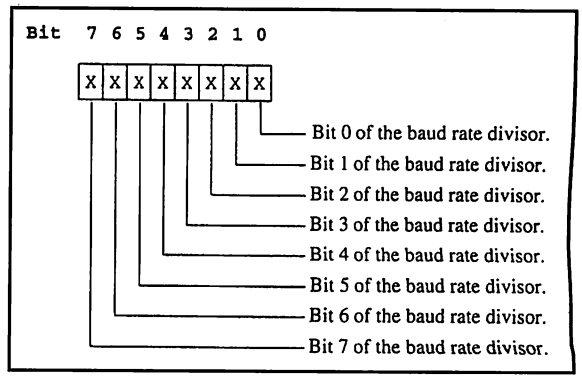


Fig. 13. Baud-Rate LSB-Divisor Latch Register.

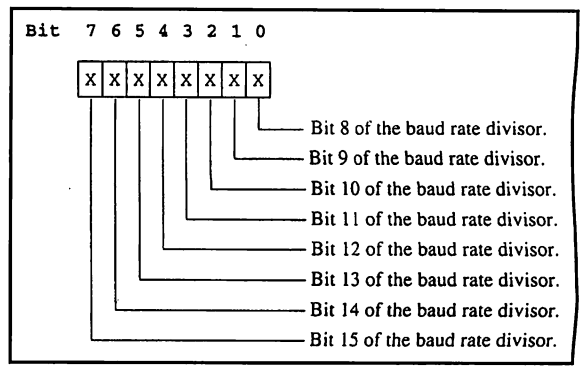


Fig. 14. Baud-Rate Divisor Register.

register shares the address of the RBR and is addressed by writing to address 0x3F8. As shown in Fig. 3, the THR is used to transmit a character out of the RS-232 interface. This register is duplicated in the 16550.

• ***Interrupt-Enable Register.*** As its name implies, the IER is used to enable interrupts and is located at address 0x3F9. Again, this register is the same one in the 16550. Note in Fig. 4 that the interrupt capability of this device permits use of these UARTs in multitasking environments.

• ***Interrupt-Identification Register.*** This register is located at 0x3FA and is used to determine what interrupt has occurred. The 8250 version of this register is shown in Fig. 5. Note the ability of this register to enable or disable the FIFOs (first-in, first-out) for the 16550 in Fig. 6. In the 8250, this is a read-only register. In the 16550, you can also write to this register to set FIFO operation. When writing to this register, use address 0x3FA. When used for setting FIFO operation, this register is called the FIFO Control Register, or FCR. The FCR is depicted in Fig. 7.

• ***Line-Control Register.*** This register is used to set the number of data bits, number of stop bits and parity bit, to name a few. This read/write register is located at 0x3FB. The 16550 register is equivalent and is shown in Fig. 8.

• ***Modem-Control Register.*** Another read/write register, the MCR sets DTR and RTS and enables interrupts. Figure 9 represents the MCR register for both the 8250 and 16550. The MCR is addressed at 0x3FC.

• ***Line-Status Register.*** The LSR is used by the UART to report availability of received data, errors and transmission-complete condition. The contents of this register, shown in Fig. 10, are read from location 0x3FD. The 16550 version of this register, shown in Fig. 11, includes a FIFO error bit.

• ***Modem-Status Register.*** This register is read to obtain the current states of the CTS and DSR lines and indicates the current state of the DCD and RI. Figure 12 details the bit structure for both the 8250 and 16550. The MSR is addressed at 0x3FE.

• ***Baud-Rate LSB-Divisor Latch Register.*** The DLL is used to set the least-significant bit of the baud rate divisor. To obtain access to this register, you must set the LCR DLAB bit to 1. By virtue of the DLAB bit, this register shares the location 0x3F8 with the RBR and THR. The baud-rate divisor is calculated by dividing the desired baud rate into 115,200 decimal. The lower eight bits of the result are placed in the DLL. Figure 13 shows the bit layout of this 16550/8250 register.

• ***Baud-Rate Divisor Latch Register.*** The high-order eight bits of the baud-rate divisor result are loaded into this register. The DLM shares 0x3F9, the IER, in the same way the DLL shares 0x3F8. This register is identical in the 8250 and 16550. Figure 14 describes this one.

Remember that the UART signal levels are TTL and must be converted to RS-232 levels with special voltage-translation ICs like the MAX232 or MAX233 before being presented to the RS-232 interface.

Modems

I won't spend a lot of time on this topic because most of you have set up and used a modem. The most-important thing to know about today's modems is how to communicate with them.

Hayes instituted a standard with its AT command set. Essentially, AT comes from ATtention. If you bring up your favorite communications pro-

gram to a blank screen and type in AT, the modem should return OK. You can then use the many AT commands to initiate a dial sequence, set data-compression modes and control RS-232 control signals like DTR, RTS and DSR.

The AT commands vary from modem to modem and are detailed in the manuals that accompany each modem.

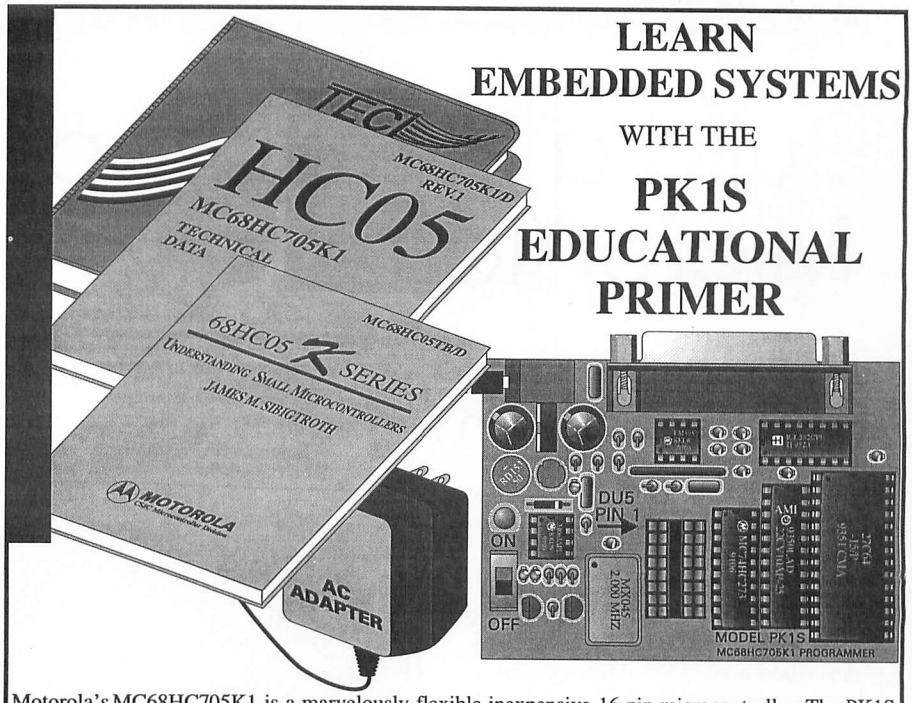
The best way to get a feel for the different compression schemes and protocols is to try them. The EDTP BBS supports V.34, V.FC, V.32bis, V.32, V.22bis, V.22 and V.21 international standards, as is the case for the Bell 103 and Bell 212A U.S. standards. It also supports MNP5 protocols for error correction and data compression. Modem data rates are 28.8K bps down to 300 bps. Consult your modem and communications program manuals for details on how to setup these protocols.

Sometimes, knowing exactly how RS-232 works isn't quite enough. When designing new serial-based equipment, I use a sophisticated RS-232 data monitor. Called a datascope, this device allows me to see and capture the RS-232 signals and actual asynchronous data in realtime for analysis.

There's no need for the average user to carry a datascope when a breakout box will suffice. A breakout box is a simple device that has LED indicators for monitoring the status of the RS-232 interface. Breakout boxes are good for determining if you have all of the proper signals needed to establish a connection. Most commercial breakout boxes also permit RS-232 circuits to be included, excluded and even tied together for special purposes.

If you wish to experiment with RS-232, the EDTP BBS offers numerous communications routines written for a variety of microcontrollers. You'll also find RS-232 routines written in C and *Quick Basic* for PCs.

I am always happy to discuss electronics and communications with any of you. So feel free to call me at 800-499-EDTP, or fax me at 407-454-9905. You can also pose questions on the Internet by addressing your e-mail to edtp@ddi.digital.net. CompuServe can reach me at 75151,2735. The EDTP BBS telephone number is 407-454-3198 and is on-line 24 hours a day, seven days a week. ■



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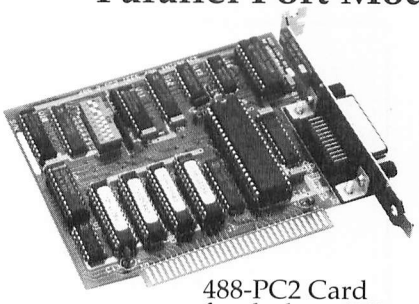

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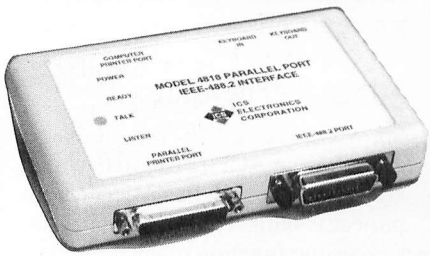

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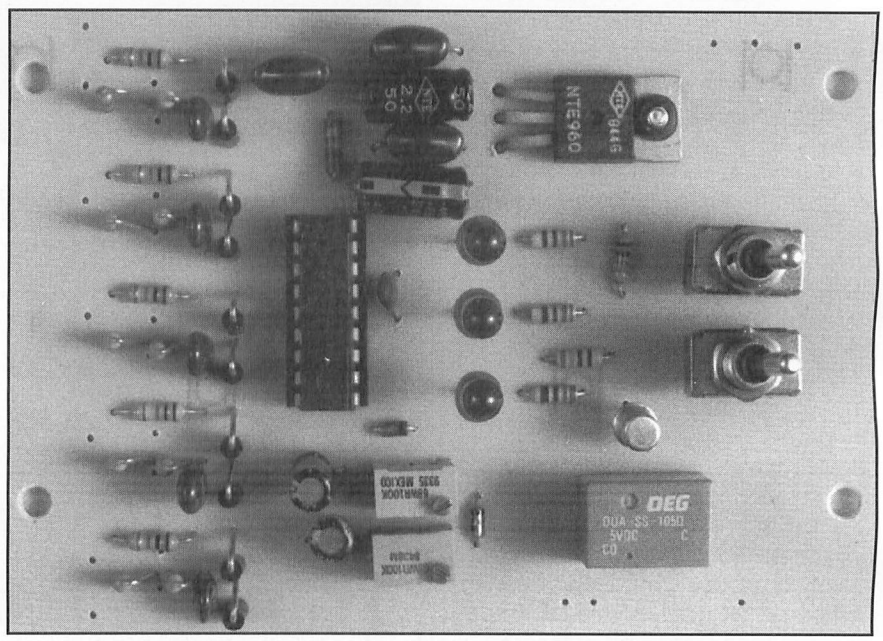
By T.L. Petruzzillis

Build a PIC-Based MicroAlarm

This low-cost miniature alarm offers features and flexibility of much more elaborate-appearing devices

If you've considered installing a security system in your home or office but have been put off by the high prices of commercial systems, take a look at the MicroAlarm described here. This alarm system on a chip is based on a preprogrammed PIC 1654 RC/P chip. Don't be lulled into thinking that MicroAlarm's diminutive size and low cost make it a "bare-bones" system capable of minimal security surveillance. Built-in sophistication lets you use MicroAlarm in many different security applications in your home and office, your car or RV and even while traveling and camping out.

Among MicroAlarm's advanced features are four independent alarm zones and a full-time (24-hour) panic zone, each with separate zone reporting. Other features include adjustable alarm time, exit/entry timers, conditioned input circuits that permit both normally-closed and normally-open switch loops and sensors and status indicators that assist in interrogating the system.



About the Circuit

Shown in Fig. 1 is the pinout diagram for the ACPIC Microalarm chip around which this MicroAlarm project is built. Table 1 lists and describes the function of each pin on this PIC device.

The complete MicroAlarm schematic diagram is shown in Fig. 2. As you can see, the entire security system consists of ACPIC Microalarm controller chip *U1* and a handful of external components.

When power is first applied, *U1* begins to discharge the timing capacitors by pulling low for a brief time Read/Ready pin 11. Next, EED pin 10 briefly goes high. Once pin 10 is considered high, *U1* saves the exit/entry delay value. Then pin 11 goes low once again for a moment to discharge the alarm-duration capacitor. It then waits for AD pin 9 to go high, at which time *U1* saves the new tim-

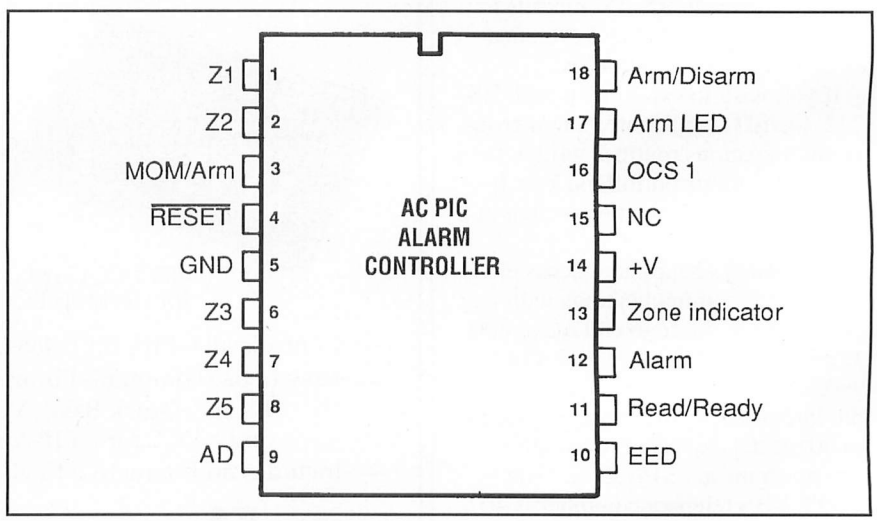


Fig. 1. Pinout diagram of ACPIC Microalarm chip.

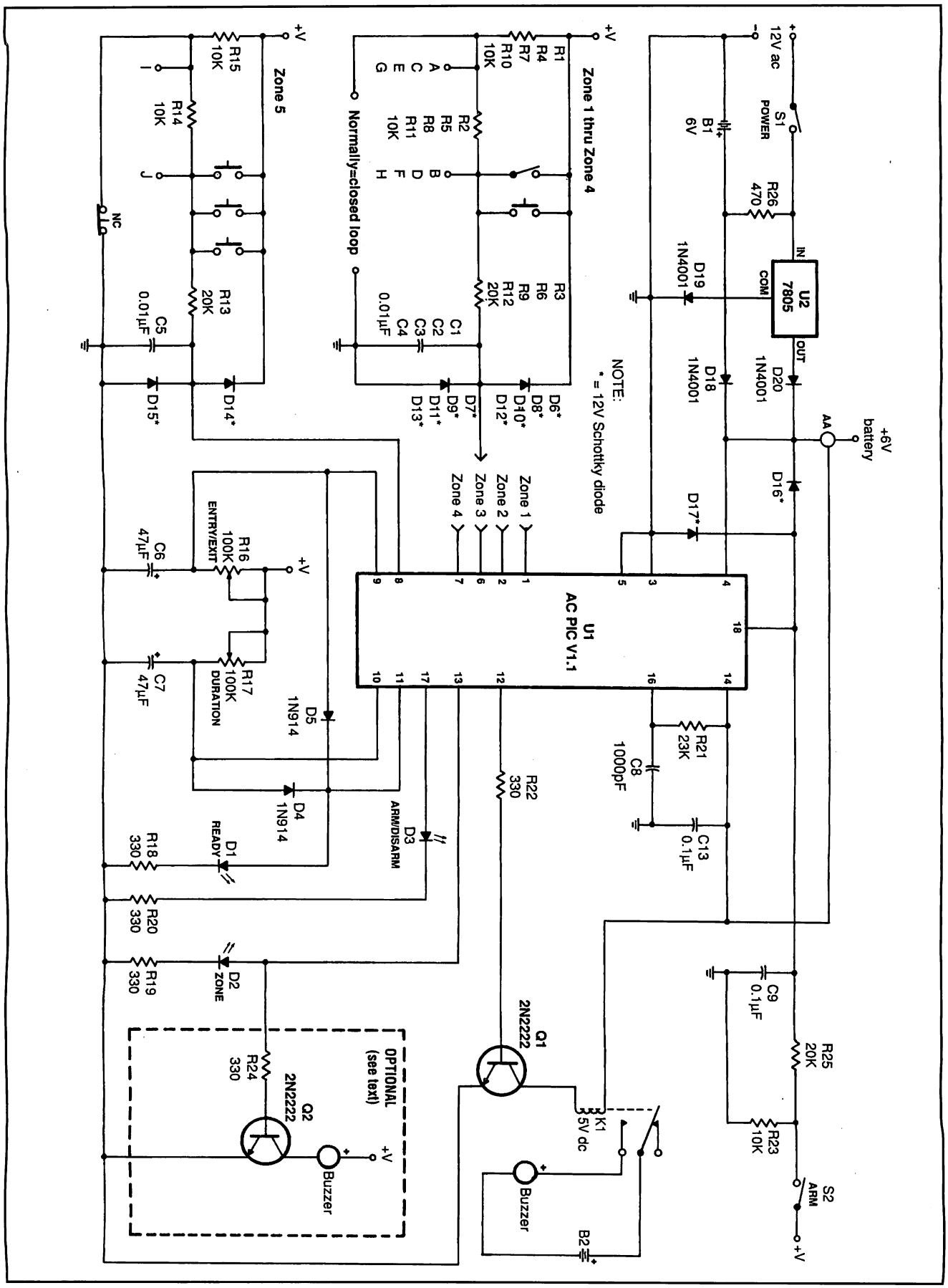


Fig. 2. Complete schematic diagram of MicroAlarm circuitry.

PARTS LIST

Semiconductors
D1,D2,D3—Red light-emitting diode
D4,D5—1N914 silicon diode
D6 thru D17—12-volt Schottky diode
D18,D19,D20—1N4001 silicon diode
Q1,Q2—2N2222 general-purpose pnp silicon transistor
U1—ACPIC preprogrammed Microalarm chip
U2—7805 fixed +5-volt regulator

Capacitors
C1 thru C5—0.01-µF, 25-volt ceramic disc
C6,C7—47-µF, 25-volt electrolytic
C8—1,000-pF, 25-volt Mylar
C9,C11,C13—0.1-µF, 25-volt ceramic disc
C10—2-µF, 25-volt electrolytic
C12—10-F, 25-volt electrolytic

Resistors (1/4-watt, 5% tolerance)
R1,R2,R4,R5,R7,R8,R10,R11,R14, R15,R23—10,000 ohms
R3,R6,R9,R12,R13,R25—20,000 ohms
R21—23,000 ohms
R18,R19,R20,R22,R24—330 ohms
R26—470 ohms
R16,R17—100,000-ohm trimmer potentiometer

Miscellaneous
K1—5-volt spdt relay with contacts rated at 125 volts at 2 amperes (Radio Shack Cat. No. 275-243 or similar)
S1—Spdt toggle switch
S2—Spst switch (key or hidden switch; see text)
Printed-circuit board; piezoelectric buzzer(s); sensors (see text); 15-position screw-type barrier strip; suitable enclosure (see text); socket for U1; spacers; machine hardware; hookup wire; solder; etc.

Note: The following items are available from T.L. Petruzzellis, 340 Torrance Ave., Vestal, NY 13850: MicroAlarm Kit No. MA-1(includes all parts, pc board and microcontroller chip but not including switches, batteries and enclosure), $41.95; ready-to-wire pc board No. MA-PC, $9.95; preprogrammed MicroAlarm chip No. MA-0CH, $14.95. Add $3/$1 ($4.50/$2.25 Canadian) shipping and handling for kit/parts orders. NY residents, add appropriate sales tax. Allow two to four weeks for delivery.

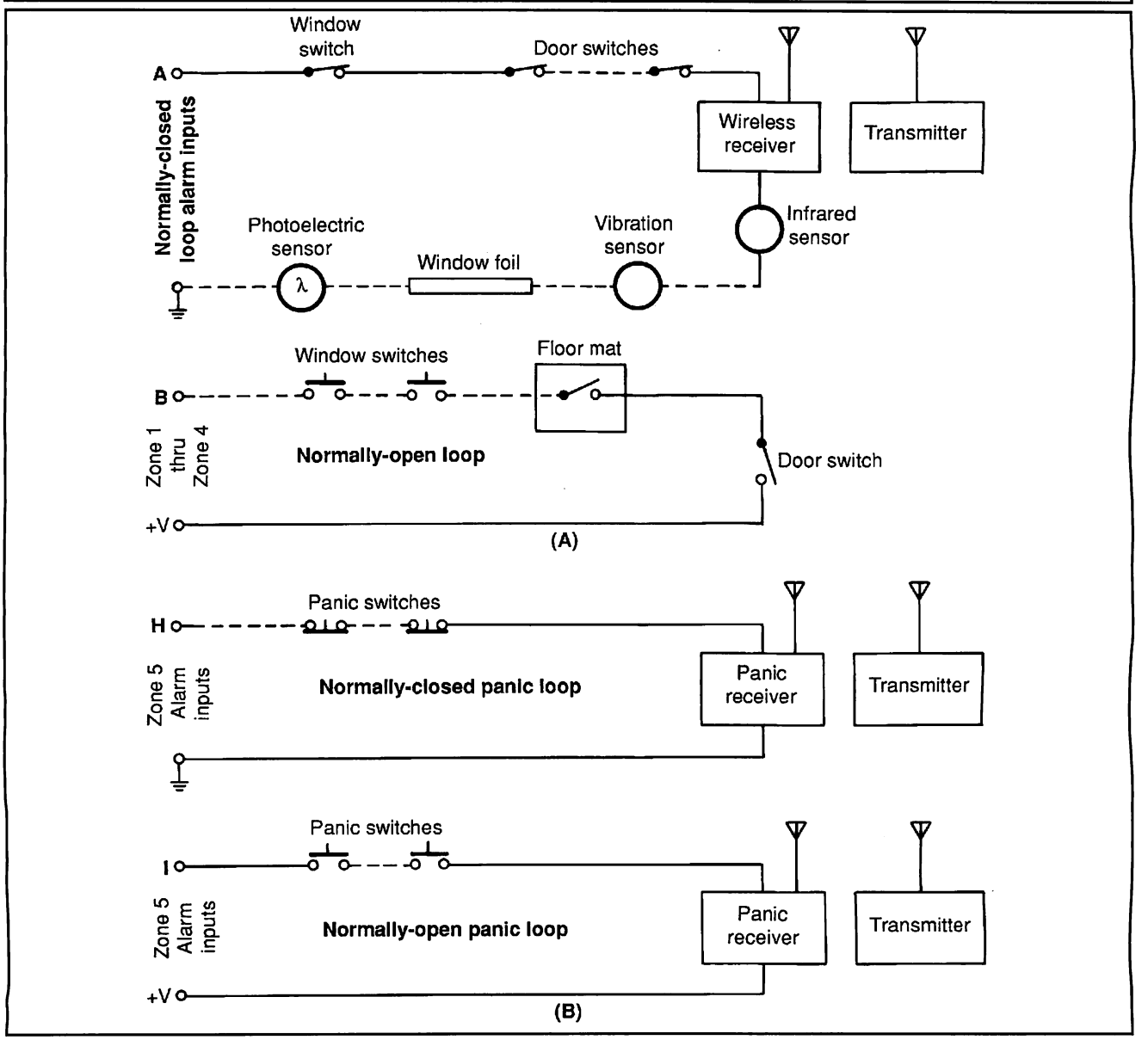


Fig. 3. Most alarm systems employ a combination of both normally-closed and normally-open switches and sensors.

Table 1. MicroAlarm ACPIC V1.1 Pin Assignments

Pin	Function	Description
1	Zone 1	High-level input on this pin registers a trip at this zone in armed mode or causes Read/Ready line to go low in disarmed mode. (Z1 through Z5 are debounced internally.)
3	Zone 2	Same as Zone 1 but indicated as Zone 2 after trip has occurred. Rising edge toggles Arm/Disarm status. When rising edge is detected, Arm/Disarm pin is no longer monitored. No debounce on this pin.
4	Reset	Low on this pin causes reset condition, forcing reread of delay settings and "pulse readout" of those settings before part is ready for operation also occurs for power on.
5	GND	System power ground (negative)
6	Zone 3	Same as Zone 1, but indicated as Z3 after trip occurs.
7	Zone 4	Same as Zone 1 but indicated as Z4 after trip occurrs
8	Zone 5	24-hour panic input. Registers trip on this zone whether system is armed or disarmed.
9	Alarm Time Delay Sense	Used by chip on power-up or after reset to read delay value for alarm condition.
10	EED Entry/Exit Delay Sense	Used upon power-up or reset to read exit/entry time delay.
11	Read/Ready	Goes low on a power-up or reset to discharge timing delay capacitors. After readings are taken, remains high unless any Z1 through Z4 is tripped. Remains low while any of Zones Z1 through Z4 is tripped and clears immediately after zone is cleared.
12	Alarm Active	Goes high during active alarm condition and remains high until alarm delay has expired, at which time it goes low.
13	Buzzer Buzzer/Annunciator	Used to "pulse out" information is about to become armed. Pulses when chip is powered on, indicating time for exit/entry and alarm. Remains low until chip is told to arm, at which time, it pulses high and then low until chip has counted down its exit delay and then remains off. Once a Z1 through Z4 has been triggered, remains on until chip is disarmed or exit/entry delay expires and alarm condition begins.
14	+V Positive Supply Voltage	Chip operates from 3 to 6 volts dc.
15	N.C.	No connection.
16	OSC1	Connection for RC master oscillator.
17	Arm	Arm/Disarm status indicator. Pin goes high once chip is armed and low when chip is disarmed. Intended to drive a LED.
18	Arm/Disarm	Level-sensitive input puts chip in disarmed state when low and begins arming sequence when first set high after a low (disarm). Debounced internally. State of this pin is irrelevant if rising edge is ever detected on Mom/Arm pin.

ing value as the alarm-duration delay.

Chip *U1* is now ready to report its findings. It first reports the number of approximate seconds for the exit/entry delay, which it reads from timing capacitor *C7*. Reporting is performed by pulsing ZONE indicator light-emitting diode *D2* once for each second it will count. This value can be set from 1 to 255 seconds.

Controller *U1* now waits for a short time before pulsing *D2* once again for the Alarm Duration Timer. LED *D2* is now pulsed once for every 5.5 seconds the alarm output on pin 12 is high, during an alarm condition. The Alarm Duration Timer can be set from 1 to 255 for a 5.5-second to 23-minute duration.

Next, *U1* begins to monitor the alarm zones and the Arm/Disarm line on pin 18. If *U1* isn't armed, Read/Ready pin 11 goes low whenever Zones 1 through 4 are activated to drive READY indicator *D1*. Now, when *U1* detects an arm signal on pin 3 or 18, it begins the arming sequence.

The arm/disarm condition is indicated by ZONE indicator *D2*, which pulses in approximate 1-second intervals until the exit/entry time has expired. Once this has occurred, ARM/DISARM indicator *D3* goes high to indicate that the system is armed. Now if any of the four alarm zones is activated after this, the exit/entry countdown begins. During the countdown period, after an alarm condition has occurred, the Zone indicator line is held high.

Once the exit/entry time period has counted down, the alarm output on pin 12 goes high, energizing relay *K1* until the alarm-duration time period expires. Relay *K1* is then deenergized, completing an alarm cycle.

If Arm/Disarm pin 18 is brought low during the alarm entry-delay period, *U1* returns to disarm mode. If an alarm condition occurs when the chip is disarmed, the zone that was tripped causes the ZONE indicator to pulse repeatedly for the same number of times as the number of the zone in which the trip occurred until an arm/disarm signal is received.

Though I used a LED as a ZONE indicator, you can substitute a piezoelectric sounder, if you wish. In my MicroAlarm, I utilized the debounced level-sensitive Arm/Disarm input on pin 18 rather than the momentary Arm/Disarm input on pin 3, which isn't conditioned and has no debounce circuit.

To arm/disarm MicroAlarm via the level-sensitive input on pin 18, use either a toggle switch on the circuit board at *S2* or a keyswitch for this function. A keyswitch is perhaps a better choice because this switch must be left in the armed position once the system is in the ready or armed state.

You can use a hidden toggle switch or keypad entry circuit in place of a keyswitch. If you implement the momentary Arm/Disarm input on pin 3, you must supply +5 volts via a debounced switch instead of activating pin 18. Once triggered, the momentary Arm/Disarm line becomes inactive until after an alarm condition has expired. I preferred to use the supervised and conditioned Arm/Disarm line on pin 18, but the choice is yours.

You can activate the Panic Zone input on pin 8 of *U1* at any time, day or night, with the controller armed or unarmed. If the ACPIC controller is disarmed when Zone 5 is activated, *U1* must be armed and then disarmed again to clear its registers. Once cleared, the ZONE indicator pulses

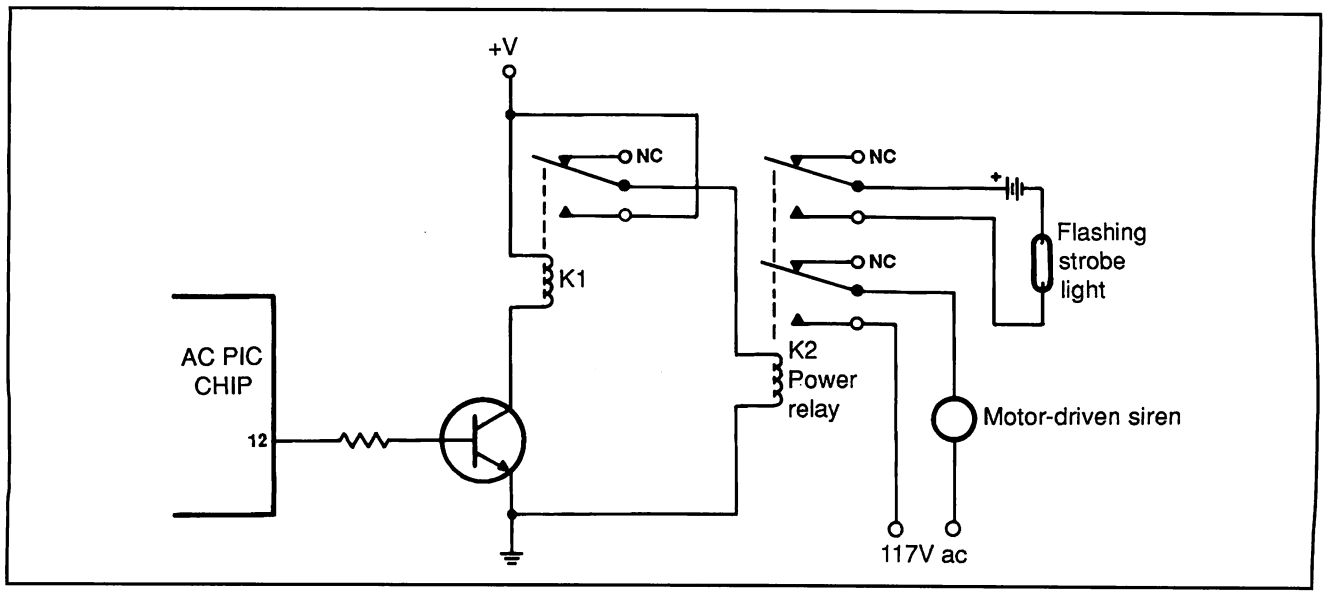


Fig. 4. If you plan on operating a large motor-driven siren or multiple output devices, you must use the on-board relay to drive a second power or multi-contact relay.

five times between intervals to indicate that Zone 5 was activated. Keep in mind that the ACPIC chip resets any of the zones after the alarm time has expired, provided that the particular zone is in a clear state.

The heart of the MicroAlarm controller is the system clock, which operates at 32.767 kHz via *R21* and *C8*. The Alarm Duration and Exit/Entry Timers consist of trimmer potentiometers *R16* and *R17* and 47-µF capacitors *C6* and *C7*.

The inputs to all five alarm zones are preceded by a hardy zone conditioning circuit that consists of two Schottky diodes, a capacitor and three resistors. The input networks serve two purposes: they reduce any statically-induced currents along the sensor input lines and they permit use of both normally-closed and normally-open switches and sensors at the same time.

Most alarm systems employ a combination of both normally-closed and normally-open switches and sensors, as illustrated in Fig. 3. Generally, most alarm installers prefer to use normally-closed switches and sensors wired in a series "supervised" loop. Normally-closed switches in a series loop let you quickly determine the condition of the wiring and the sensors in the loop. Any open door or window can be seen instantly prior to arming the system.

Many different types of normally-closed switches and sensors can be wired together in a series loop, including door switches, window switches, window foil, infrared body-heat sensors and/or photoelectric sensors. Panic Alarm loops, on the other hand, generally use momentary-open type switches or sensors that are strategically located around the premises under surveillance. Often, wireless Panic Alarm receivers are connected into the panic loop.

MicroAlarm also lets you use its normally-closed "supervised" loop feature found in Zones 1 through 4. If you don't use a particular normally-closed loop, you must tie a jumper from that loop's normally-closed sensor post on the circuit board to a ground point to simulate a normally-closed loop.

The output on pin 11 of *U1* provides a system READY indicator via *D1*. The alarm output on pin 13 drives ZONE indicator *D2*, while the output on pin 17 drives ARM/DISARM LED *D3*.

The alarm output on pin 12 of *U1*

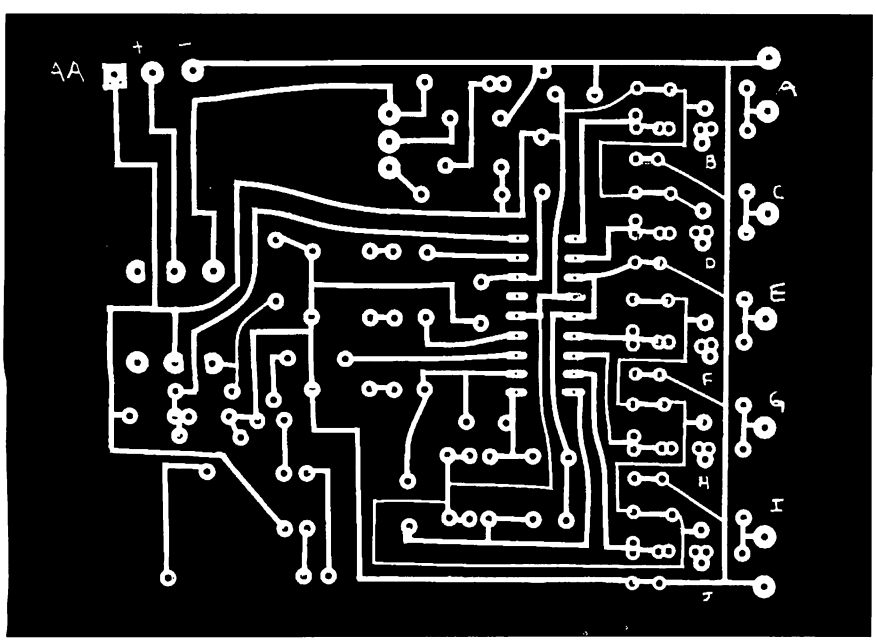


Fig. 5. Actual-size etching-and-drilling guide for printed-circuit board.

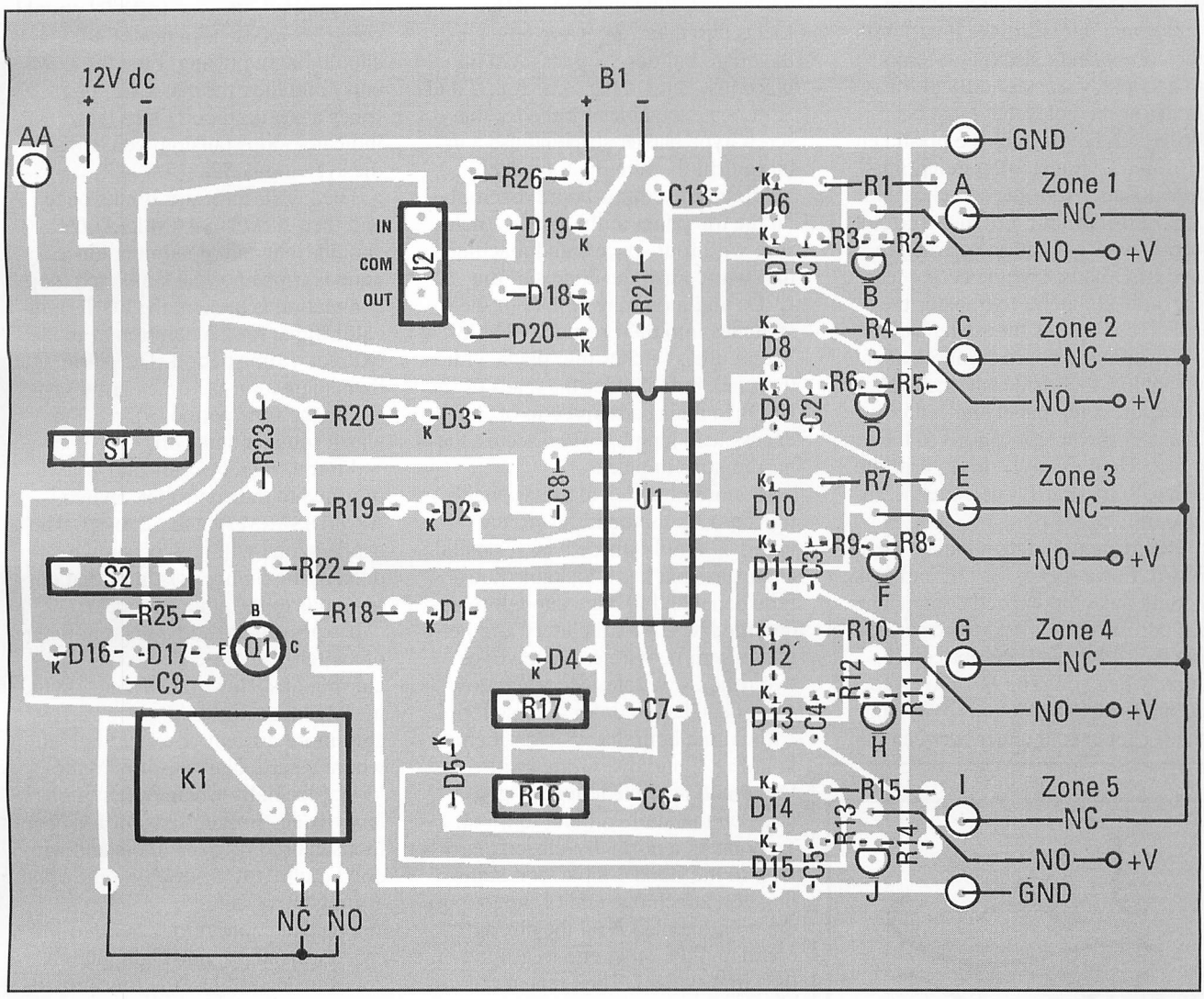


Fig. 6. Wiring guide for pc board.

drives transistor *Q1* that, in turn, activates relay *K1*. This relay has both normally-closed and normally-open contacts that can be used to activate an audible alarm, siren, bell or automatic telephone dialer.

If you plan on operating a large motor-driven siren or multiple output devices, you must use the on-board relay to drive a second high-power or multi-contact relay, as shown in Fig. 4. To implement a silent automatic telephone dialer, connect the relay output to your dialer's input and decrease the value of the Alarm Duration timer to the minimum time-period value.

You can power the MicroAlarm controller in several different ways. The on-board 5-volt regulator is configured to continuously charge a set of four AA-size Ni-Cd cells via a 12-volt dc plug-in power cube for running the alarm from battery at all times. If power fails, MicroAlarm continues to operate as normal with this powering scheme.

You can also power MicroAlarm directly from a 6-volt lantern battery for portable and camping applications by connecting a battery to the point labeled AA in the circuit. This point bypasses the regulator and goes directly to controller chip *U1*. It isn't switched via *S1*. Note that *U1* can operate from 3 to 6 volts dc and that the relay used for this project is a 5-volt type.

In standby, MicroAlarm consumes only 60 µA of current. Hence, it readily lends itself to portable alarm applications. In travel situations, a single infrared heat sensor with a self-contained battery and small piezoelectric buzzer could readily protect your motel room. When used while camping, the portable self-contained MicroAlarm could be set up using a simple loop of 35-gauge wire strung around the campsite.

Construction

You can assemble and wire MicroAlarm on a 4¼" X 3" printed-circuit board, which easily fits into a compact 5½" X 3¼" X 1¼" Pactec enclosure, along with an internal piezoelectric buzzer for simple alarm applications. You can fabricate your own pc board using the actual-size etching-and drilling guide shown in Fig. 5. Alternatively, you can obtain a ready-to-wire board from the source given in the Note at the end of the Parts List. Another alternative is to wire the project on a piece of perforated board that has holes on 0.1" centers, using suitable Wire

Wrap and/or soldering hardware.

Before populating the board with the components, use it as a template to accurately transfer critical locations for the holes that must be drilled in the cover of the plastic enclosure. To transfer the mounting-hole locations for the switches and LEDs, drill pilot holes in the circuit board at each location between the two LED pads. Use the center lead for both *S1* and *S2* to transfer the hole locations for the switches.

Position the board component side up against the inside surface to the enclosure's top panel and center it. Transfer the hole locations to the top panel. Then use a 1/4" bit to drill the holes. Temporarily set aside the enclosure.

Referring to Fig. 6, populate the pc board. Use a socket for *U1*, and make certain that all polarized components are correctly oriented before soldering their leads and pins into place. Also, when you plug *U1* into its socket, make sure that no pins overhang the socket or fold under between IC and socket. Plug the leads of the LEDs into their respective holes in the board but don't solder them into place just yet. Do the same for *S1* and *S2*. Locate the holes for the for the screw-type barrier strip and use a 1/8" bit to drill them in the top panel.

Mount the circuit-board assembly on the top panel of the plastic enclosure with four spacers and machine hardware. Push the domes of the LEDs and mounting collars of the switches into their respective holes. Secure the switches into place with their hex nuts. Solder the leads of the LEDs to their pads and clip off any excess lead lengths. Then secure the barrier strip in place.

In more-complex alarm applications, you can mount the circuit-board assembly inside a larger metal enclosure that has a lockable door-type panel and is large enough to accommodate a Ni-Cd battery and perhaps a remote wireless receiver or two (one for wireless door/window sensors and another for a Panic loop).

Examine both the system schematic in Fig. 2 and the wiring guide in Fig. 6 and note the letter designations on the alarm's input terminals. To connect a normally-closed alarm loop to the Zone 1 input, for example, you attach one end of the loop to the point labeled A on the circuit board and the other end to ground on the circuit board. Then repeat this procedure for the other alarm zones.

If you wish to use normally-open sensors in Zone 1, connect one end of the normally-open parallel circuit between point B and the other end to a +6-volt point on the board. Repeat this for the other normally-open alarm loops.

Before proceeding to checkout, check your circuit-board assembly to make sure all the diodes and transistors are installed correctly. Check your soldering, too, paying particular attention to solder blobs and stray component leads that could short out your project.

Checkout and Use

Connect the alarm loops to the project via the barrier strip, or simulate the five normally-closed loops with jumpers from A, C, E, G and H to ground. Apply power to MicroAlarm by closing switch *S1*. When power is first applied, READY LED *D1* should come on and Zone indicator *D2* should begin pulsing. First the exit/entry and then the alarm-duration times are pulsed out. Once the ZONE indicator stops pulsing, you can arm the system via *S2*.

The ZONE indicator blinks once and then ARM/DISARM LED *D3* should light and remain on. Once a zone is tripped or the simulated loop connection is broken, the ZONE indicator lights for the duration of the exit/entry time period. The alarm then sounds for the time period set. When the time period expires, the alarm sounder shuts off.

After a trigger occurs and you've returned to the controller, switch ARM/DISARM switch *S2* to off. The tripped zone will now be shown pulsing the number of times that corresponds to the zone's number.

It's possible to add a great number of switches and sensors to the four alarm loops. However, if you add too many sensors, it becomes considerably more difficult to keep track of where a particular sensor is in the loop, especially when system problems occur. Broken sensors and open loops caused by open doors and windows can really be troublesome upon arming the system.

You can connect together two MicroAlarms to provide eight alarm zones instead of just the four provided by a single MicroAlarm system. Going this route, you have a better idea of where faulty sensors and line problems occur as your system expands.

To use two controllers, simply parallel the normally-open relay contacts from both controllers. Power to the separate controllers can be supplied via a dpdt switch. Keep separate the Arm/Disarm lines from both controllers and separately arm each controller.

You can use MicroAlarm to protect a number of computers in a laboratory or office machines and computers in a business environment. Place a small "spot" sensor mat under a computer or fax machine or attach a low-cost gravity tilt-ball sensor on each machine to protect many machines against theft at a low cost. With this approach, you can protect a number of office machines day and night on Zone 5, while people are working. ■

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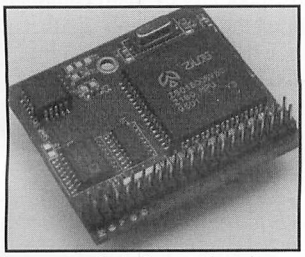
CIRCLE NO. 68 ON FREE INFORMATION CARD

parallel-port interface cable, power supply and programming software. It comes in both kit and assembled forms. $29/$49. kit/assembled. *ITU Technologies, 3477 Westport Ct., Cincinnati, OH 45248-3026; tel.: 513-574-7523.*

CIRCLE NO. 29 ON FREE CARD

Microprocessor Core Module

The SmartCore printed-circuit board from Z-World Engineering contains the common components needed in all microprocessor systems, including: processor, memory, power control, watchdog and clock. Only interface and control logic are needed. SmartCore is available in four configurations, giving you a choice of RAM, optional parts and speed. $59 and up. *Z-World Engineering, 1724 Picasso Ave., Davis, CA 95616; tel.: 916-757-3737; fax: 916-753-5141.*



CIRCLE NO. 30 ON FREE CARD

SOFTWARE

Windows CAD

Draft Choice Version 2.00a from TRIUS is a computer-aided-design program for *Windows*. Basic drawing commands include lines, boxes, Bezier curves, circles, polygons, freehand and others. All are vector-based and totally rotate-able and scale-able. More-sophisticated options include Attach to Endpoint, Midpoint, Intersection, Reference Point or Closest Point on a line. Other features include orthogonal and isometric modes, grid and snap options, 128 layers and automatic dimensioning. *Draft Choice* supports a number of formats including .DXF, .WPG, HPGL, .DCH, and ASCII. $59. *TRIUS, Inc. 231 Sutton St., Ste. 2D-3, PO Box 249, N. Andover, MA 01845; tel.: 508-794-9377; fax: 508-688-6312.*

CIRCLE NO. 31 ON FREE CARD

Noise-Removal Software

Tracer Technologies' *DART* software is designed to remove all surface noise, pops, clicks and other audio disturbances from any audio source. After recording with any *Windows*-compatible sound card, *DART* applies a three-part process to sound files called TriCleanse, which includes a Smoothing Processor to smooth/reconstruct the signal at the first stage of the noise-canceling procedure. Next, a Postfiltering Processor removes surface noise, hiss and other constant distortion. Finally, an Outlier Detector searches for pops, clicks and other impulsive noises and automatically removes them. *DART*'s toolbox also includes an eight-band graphic equalizer, sound editing and splitting, filtering, video and audio markers, gain adjuster, mixer and others. $399. *Tracer Technologies, Inc., PO Box 188, Dallastown, PA 17313; tel.: 717-747-0200; fax: 717-741-6790.*

CIRCLE NO. 32 ON FREE CARD

Fax Listings

PhoneDisc Fax from Digital Directory Assistance features more than 250,000 published US Fax listings. The program lets you search by name, address, business type, fax number or SIC code. $39. *Digital Directory Assistance, Inc., 6931 Arlington Rd, Ste. 405, Bethesda, MD 20814-5231; tel.: 800-284-8353.*

CIRCLE NO. 33ON FREE CARD

Long Filenames for Windows

Vertisoft's *Name-IT* for *Windows 95* allows *Windows* 3.x applications to use long filenames in *Windows 95*. One of *Windows 95*'s new features is the ability to use long filenames. However, the existing *Windows* 3.x applications are still restricted to using the old DOS 8.3 filenames. *Name-IT* automatically updates *Windows* 3.x apps to correct this problem. It works either by automatically replacing the existing Open and Save As dialog box with a *Windows 95* long-filename dialog box or by seamlessly adding a command button to the Open and Save As dialog box that, when clicked, displays a *Windows 95* long-filename box. $59.95. *Vertisoft Systems, Inc., Four Embarcadero Center, Ste. 3470, San Francisco, CA 94111; tel.: 800-466-5875; fax: 800-466-4719.*

CIRCLE NO. 34 ON FREE CARD

Windows Network Diagrammer

Nodemap for Windows from HavenTree Software automatically diagrams LAN and WAN configurations and provides the tools and information needed for administrators to design and manage Novell *NetWare* networks. Operational view displays all available network devices on a single diagram, while Executive view provides a system overview with multiple levels of further details. Undetected or future information can be manually inserted. $499. *HavenTree Software, Ltd., PO Box 2260, Kingston, Ontario, Canada K7K2L9; tel.: 613-544-6035; fax: 613-544-9632.*

CIRCLE NO. 35 ON FREE CARD

Memory Expander

MagnaRAM from Landmark Research is software that boosts the amount of available *Windows* memory by up to four times. It uses *Windows* drivers to compress RAM and *Windows* Virtual Memory. When *Windows* attempts to uses slower Virtual Memory, *MagnaRAM* intervenes, compresses the data and stores it to physical RAM. When no more room is available for compressed RAM, *MagnaRAM* compresses Virtual Memory. *MagnaRAM* is claimed to be fully compatible with memory management software. $129. *Landmark Research International, Inc., 703 Grand Central St., Clearwater, FL 34616; tel.: 813-443-1331; fax: 813-443-6603.*

CIRCLE NO. 36 ON FREE CARD

Windows Design Software

MicroBench from MicroBench Software is an electronic design automation (EDA) program that guides you through selection of operational functions to create microcontroller-based products. It produces a system block diagram, circuit schematics, parts list, program listing and assembly-level object code. *MicroBench* prompts, error checks and eliminates design iterations in the development process.

MicroBench has pre-programmed functions and associated circuits stored for ready access in libraries. Analog and digital inputs and outputs, visual readout and memory functions are available. Libraries are open for inspection and can be extended, if desired. Designs in the initial release are based on the Microchip Technology PIC chips and can perform functions commensurate with this processor's capability. $695. *MicroBench Software, Inc., 1180-A Aster Ave., Sunnyvale, CA 94086; tel.: 408-248-7776; fax: 408-248-6651.*

CIRCLE NO. 38 ON FREE CARD

Electronics Dictionary

Lambda's *Spell-Tech* spelling dictionary for Electronics and Electrical Engineering integrates industry-standard words and abbreviations with the existing spelling dictionaries for DOS and *Windows* versions of *WordPerfect*. $35. *Lambda Publishing Group, PO Box 1894, Lawrence, KS 66044-8894.*

CIRCLE NO. 37 ON FREE CARD

(Continued on page 112)

Microcomputer Q & A

By TJ Byers

In this column, I answer questions about all aspects of computer disciplines, both hardware and software, plus related electronic queries. You can reach me on America Online at TJBYERS, on CompuServe or Internet at TJBYERS@aol.com or by mail at *MicroComputer Journal,* 76 N. Broadway, Hicksville, NY 11801.

Where's the RAM?

Q. *I'm having a problem with a 486 motherboard that won't recognize any memory over 1M. Compounding the problem is the fact that the system was shipped with the wrong manual, and the purchasing department can't link up the shipment with a purchase order. So I don't have a tech-support number, either. This is obviously a generic motherboard that should work right out of the box—and it does, except for the lack of memory recognition. Any ideas? BIOS maybe?*—John Adams
via Internet

A. Three things come to mind as to why this generic motherboard doesn't recognize extended memory. First make sure your CONFIG.SYS file contains the line: device=C:\DOS\HIMEM.SYS. Also, make sure that if the CONFIG.SYS file contains an expanded memory driver, like EMM386.SYS, that the NOEMS switch is included in this line.

As a rule, you need to populate the memory banks with pairs of identical SIMMs, beginning with Bank 0. Filling Bank 1 before you fill Bank 0 can cause the problem you describe. Sometimes, you can mix and match memory sizes, like having two 4M SIMMs in the first memory bank and two 2M SIMMs in the second memory bank (for a total of 10M), but not always.

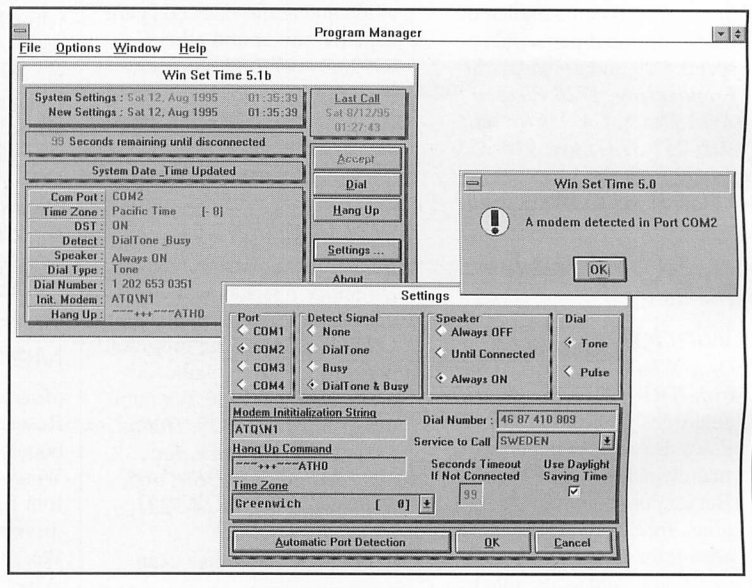
The problem could also be in the SIMMs themselves. SIMMs come in two types—30-pin and 72-pin—that aren't interchangeable. Sometimes, the motherboard requires a proprietary SIMM type that may look like a standard SIMM but is electrically different. Also, check the direction in which you inserted the SIMM modules. While the SIMMs slots are designed to accept the modules in only one direction, cheap-quality sockets can let you plug them in backwards. If you have to force a SIMM into its socket, try again. The sound of a correctly-inserted SIMM ends with a clean snap.

Finally, the BIOS must be told when new memory is added. Sometimes, this is done by setting jumpers, but it's more likely done using a setup table built into the BIOS chip. The problem here is bringing up the setup program, which can be as simple as hitting the Del key on boot-up to a very-complex pattern of keystrokes.

Table 1 lists the most-popular keyboard combinations used for bringing up the setup menu. If all else fails, you can often force the BIOS's attention by unplugging the hard-disk drive while your PC is powered down and then powering on your system.

How to Identify Parity SIMMs

Q. I have a PC that uses parity-checking SIMMs. My



User Tip: Keeping up with the times when traveling abroad can be frustrating. However, it's easier to keep track of changing time zones using your modem and a software program like *Win Set Time.* This *Windows* utility dials any atomic clock in the world (including US Naval Observatory and INST), gets the universal date and time and converts it to your local time zone. The program has automatic modem recognition and can update your system's Date and Time functions, if you wish. *Win Set Time* is a shareware program that can be found on most on-line services under the filename WSTIME.ZIP.—Submitted by O. M. Xavier, San Francisco, CA.

problem is that the OEM (original equipment manufacturer) charges an arm and a leg for its SIMMs, which I understand I can buy elsewhere for half the price. My question is, how can I tell if the SIMMs I'm buying are parity SIMMs or not?—Arthur S., FL

A. This is an easy one, because it's an odd or even number. The byte is exactly eight bits wide, which is an even number. In the early days, because memory chips were very unreliable, IBM decided to add a ninth bit—the parity bit—to verify the validity of the stored data. If the ninth bit didn't coincide with the previous eight bits, the computer would display the infamous "Parity Error" screen and promptly lock up the system.

While parity checking has largely been abandoned, a few companies, like Compaq and Dell, still use parity-checking memory in a handful of their high-end products. The easiest way to determine if you're buying a parity SIMM or not is to count the chips to determine if the count is odd or even. For example, if your 30-pin SIMM has three or nine chips, it's a parity SIMM. If it has two or eight chips, it's not a parity SIMM. The same goes for 72-pin modules, except the non-parity chip count is 4, 8, 16 or 32 chips.

DRAM Vs. VRAM

Q. *I'm in the market for a new computer, and I was advised to get one with 1M of VRAM. The salesperson says the system will run better with 2M of video DRAM. My friend says DRAM is too slow for the multimedia system I have in mind. Should I accept the salesperson's DRAM suggestion or insist on VRAM?*—Paul Johnson, via Internet

A. Let's start with some basics. DRAM chips are single-port devices that alternately use their I/O pins for read and write operations. What this means is that the I/O pins must take turns sending and receiving information. VRAM, on the other hand, has two ports, one for sending and one for receiving. So while the input port is receiving new screen information, the output port is concurrently updating the display. Hence, VRAM is inherently faster than DRAM. However, it's also more expensive.

To increase video speed without incurring the cost of VRAM memory, several video cards use bank switching and use two banks of DRAM chips of 1M each. While one bank is receiving video data, the other is outputting the latest screen information to the display. After the first pass, the sender becomes the receiver and the former receiver sends the latest video data to the screen for faster throughput.

Table 1.
Common Keyboard Combinations to Bring up BIOS Setup Menu

BIOS Setup Hotkeys	Typical PC Type
<Ctrl><Alt><Esc>	Award BIOS
<Ctrl><Alt><Enter>	Award/AST/Notebook BIOS
<Ctrl><Shift><Enter>	Phoenix/Notebook BIOS
<Ctrl><Alt><S>	Phoenix BIOS, SystemSoft
<F10><Del>	Compaq BIOS
<Del>	AMI BIOS

Generally, these sequences work only during a cold boot.

And so the process goes, back and forth between banks.

As to which scheme is better, I can't say. Personally, I have and use both, and I can't see a difference between them in the long haul. They both support the same number of colors, and their speeds are comparable. So the bottom line is, what's the difference in price?

Missing Icons

Q. *I have a Compaq Presario. Over a period of time, the factory-installed version of* Windows *became extremely unstable, constantly flashing message errors on boot-up and sometimes crashing without warning. I solved the problem by performing a new* Windows *installation, but in the process, I lost most of my Compaq Control Panel icons. I really need to get them back. A screen shot of my Program Manager is shown in Fig. 1. Please help!*—BonoVox9 via America Online

A. Essentially, you've run out of *Windows* resources—which may be the reason you experienced *Windows* problems in the first place. If you count the application groups in your Program Manager window, you'll see they number 40, which is the most *Windows* 3.1 (and 3.11) supports. You may find your missing icons under the general groups of Applications 1, Applications 2 or Applications 3, but I doubt it.

To recover your lost utilities, you need to reduce the application groups to a manageable number. I suggest something in the neighborhood of 20 to 30. You can probably eliminate a lot of clutter by going into the Applications groups and deleting duplicate icons using the Delete command found in the File menu (upper-left) and then remove the group itself using the same procedure. If necessary, you can reduce the number of groups if you drag and drop icons from one group to another.

To reinstall your missing utilities, use the New command from the File menu. When prompted for the command line,

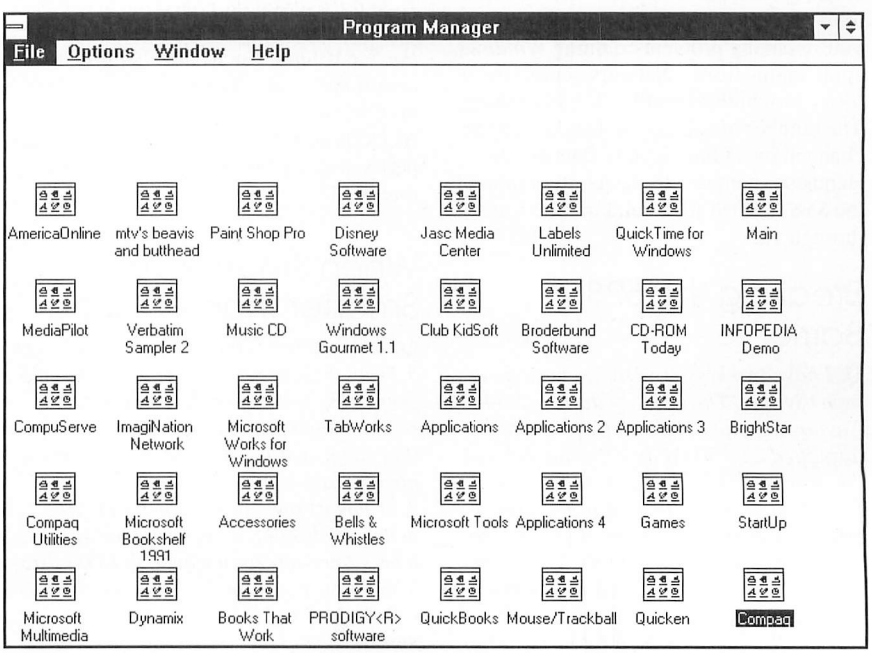


Fig. 1. Having too many icons in a *Windows* Applications group can lead to problems. In this example, the maximum number—40—is in the reader's Application group, which led to his problems.

use the Browse option and search through the directories, one by one, until you find all the ones you want back. A list of the Control Panel filenames can be found in the appendix at the end of the User's manual or calling Compaq's customer support (tel.: 800-345-1518). I know it's a royal pain in the rear, but it's the only recourse you have at this point.

Segment Load Failure Resolved

Q. *Quite often, when I exit* Word 6.0 *my computer displays the error message "Segment Load Failure." Leaving* Word 6.0 *is the only time I ever see this message. All of the other software I run seems to function perfectly well, as does* Word *until I try to exit it. The computer is a 486DX-33 with 8M running on a* Novell *network. Any suggestions ?*—Richard A. Smith via Internet

A. The fact that you're getting this message only when exiting *Word* doesn't necessarily mean *Word* is at fault. This error message may occur inconsistently or not at all due to the mechanism used by *Windows* for caching file handles. By default, *Windows* caches 12 file handles for the most-recently used files. *Windows* keeps these files open so that they can be accessed quickly, ensuring optimal performance. However, some networks have a limit on the number of files that can be open on a server at a time.

If *Windows* opens more files than the cache can hold, the cache closes the least-recently used file handles, which can lead to the problem you're experiencing. If you're having problems running *Windows* applications from a Network server, use a *lower* (not higher) number for this setting. The number of cached file handles can be changed by adding the line CachedFile Handles=<number> to the [boot] section of the SYSTEM.INI file. Valid numbers are 2 through 12.

Breaking the 528M Barrier

Q. *I have two Western Digital hard drives in my system. The primary drive is a 340 Caviar, the other is a 540 Caviar that's formatted as a 504M disk. I want to break through the 504M barrier on the second drive, which is partitioned as one logical extension, to gain the extra 36M it has to offer. However, I've been told it can't be done because 540M exceeds the DOS limit and that I'll have to partition this drive into smaller pieces, which I don't want to do. Is there any way to assign all 540M to one big logical drive?*—Donald N. via America Online

A. The capacity of a hard disk is determined by three factors: the number of sectors per track, number of cylinders per platter (tracks times 2) and total number of heads in the drive. DOS supports a maximum of 63 tracks, 1,024 cylinders and 16 heads, for a total disk-drive space of 528M. To access disk space beyond 528M, a new addressing scheme is needed, preferably one that builds on the existing DOS operating system so that it works with your older 340M hard disk.

The popular *Disk Manager* program from Ontrack (tel.: 800-752-1333) performs this magic by adding an extension to the operating system's hard-disk interrupt code using a software device driver. This addressing method is commonly called Logical Block Addressing, or LBA. LBA extends the number of heads from 16 to 255, for a total disk space of 8.4G (Table 2). When you run the *Disk Manager* installation program, the specified hard disk is reformatted and the LBA driver is automatically added to your CONFIG.SYS file. Be aware, though, that formatting your second hard drive with LBA will destroy all data on the drive. So make sure you back it up first.

Enhanced IDE Controller Question

Q. *When I upgraded to a larger-capacity hard disk, I also bought an Enhanced IDE (EIDE) controller, thinking it was needed to break the BIOS's 528M limit. However, I discovered that my new Western Digital 1.2G hard disk didn't need the new controller. It uses a software driver to break the 528M limit. I'm wondering if I should install the controller or return it and get my $90 back.*—Tai, via Internet

A. Definitely install it. It will increase the performance of your hard disk by about threefold.

When SmartDrive Is Smarter than VCache

Q. *I'm running* Windows for Workgroups *3.11 on a Gateway 2000 486DX2-66 and everything works just fine. Recently, I read a memo from Gateway's tech support that suggested I remove SmartDrive from my AUTOEXEC.BAT file because* WFW *3.11 has its own disk cache that works better. Well I did, and everything still works fine—except for my CD-ROM drive, which now runs slower. When I called the CD-ROM drive vendor, I was told to add SmartDrive to my AUTOEXEC.BAT file. I'm confused. Who's correct? Do I need SmartDrive or not?*—M. Williams, Carlisle, PA

Table 2.
Ontrack's Disk Manager Breaks 528M Hard-Disk Barrier by Fooling DOS into Believing Cylinder Numbers Beyond 1,024 are Head Numbers

Maximum Values	DOS	LBA
Sectors per Track	63	63
Number of Cylinders	1024	1,024
Number of Heads	16	255
Hard Disk Capacity	528M	8.4G

A. The Gateway memo is correct in telling you that *Windows for Workgroups* 3.11 has better caching than SmartDrive. However, the cache in *WFW* 3.11, known as VCACHE, doesn't cache CD-ROM or floppy drives. You must use SmartDrive for this. Here's where the rub comes, though, because SmartDrive can pull down the performance of *WFW* 3.11 if it isn't implemented properly.

First, you have to load MSCDEX before SmartDrive in your AUTOEXEC.BAT file. If you don't, the CD-ROM drive won't be cached. Second, SmartDrive's parameters must be carefully set. SmartDrive contains two cache size settings. The first number is the size of the cache under DOS, the second the size of the cache under *Windows*. When you enable VCACHE, *WFW* 3.11 automatically defaults the SmartDrive value to 128K when running *Windows*, a value that's too small for efficient CD-ROM caching. You can prevent VCACHE from doing this by specifying a larger *Windows* value in the SmartDrive line. For an 8M system, I suggest using a value of 2M, which is written as: C:\DOS\SMARTDRV.EXE 2048 2048.

On a related note, *WFW* 3.11 contains a driver named VSHARE that's superior to DOS's SHARE command. If you're using *WFW* 3.11, remove the line DEVICE=SHARE.EXE in the CONFIG.SYS file.

Creating A Batch File Time/Date Stamp

Q. *Our office has a "satellite" computer that's used by many persons at all hours of the day and night. To make better use of the system, I'd like to create a log of its usage. How can I write a batch file that will record the time and date every time someone boots the system?*—D. Baumgartner, via CompuServe

A. There are no batch-file commands that let you automatically write the time or date to a file. But if you don't mind having to press the Enter key a couple times

during boot-up, a time/date log file can be created. Here's an example of how it can be done.

```
echo off
cls
echo working...
echo press Enter to continue
date > file
echo working...
echo press Enter to continue
time > file1
copy bootlog.txt+file+file1 bootlog.txt > file2
del file?
```

The batch file works by routing the screen display to a file, where it's recorded in the form:

```
Current time is  4:39:33.96p
Enter new time:
```

Because TIME and DATE are questions awaiting a response, manual intervention is needed. Hence, the "press Enter" prompt. After the date and stamp files are created, they're concatenated and appended using the COPY command and then deleted. Your time/date log, in this example, is contained in the BOOTLOG.TXT file. The batch routine can be embedded in the AUTOEXEC.BAT file, or run from AUTOEXEC.BAT using the CALL <time/date filename> command.

Duplicate COMMAND.COM or a Phantom?

Q. *When I type MEM /C, I see that I have two COMMAND.COM files loaded into conventional memory. Explain to me why I need two COMMAND.COM files, when one should suffice. I'd like to free up more conventional memory by getting rid of the duplicate, but despite my efforts, it won't disappear.*—James O'Leary, Chicago

A. The reason it looks like you have two COMMAND.COMs running at the same time is because—I'm almost sure—you're looking at MEM from a *Windows* shell. *Windows* is loaded on top of COMMAND.COM (DOS). So when you shell from *Windows* to DOS, another COMMAND.COM interpreter must be loaded to prevent *Windows* from crashing. Anyway, don't worry about the 3K this file is taking up. If you want to see it gone, exit *Windows* and try typing MEM /C /P from a true DOS prompt.

By the way, if you're a player whose game collection consists mostly of DOS programs and you're looking for all the conventional memory you can free up, I don't suggest running these games from a *Windows* shell. Instead, exit *Windows* (the fastest way is to click on the File menu in the upper-left corner) and then play the game. You'll have more conventional memory available, and the game generally runs faster.

Gaining 32-bit Hard Disk Access

Q. *When I try to engage the 32-bit Disk Access option under the* Windows *Control Panel's Virtual Memory box, I get the message "The Microsoft Windows 32-bit disk driver (WDCTRL) cannot be loaded on this computer because of interrupt conflicts." How can I get 32-bit access to my drive?*—CTPynn via America Online

A. There are three conditions that can generate this error message, all of which are related to the [386enh] section of your SYSTEM.INI file.

```
> the device=*int13 line is missing
> you have the line device=multis.386 as well
  as device=*int13
> a third-party hard disk driver is installed
```

In your case, the most likely cause is that a third-party hard-disk driver has been added to the system—probably to support a large-capacity EIDE or SCSI hard disk. Using a text editor like *Windows'* SYSEDIT, browse your SYSTEM.INI file in search of the line device=*wdctrl. It should follow the line device=*int13 under [386enh]. If you can't find device=*int13, add it. If both lines exist, delete the device=*wdctrl line. Now save the changes and restart *Windows*.

DSVD: New Modem Standard?

Q. *I have several questions about the DSVD modems now on the street. What exactly do they do that other modems don't? Is it true a DSVD modem can't send and receive data with a non-DSVD modem? Finally, is DSVD expected to become the standard for the future?*—Dallas, via Internet

A. DSVD, which stands for Digital Simultaneous Voice and Data, lets you use a single telephone channel to communicate voice and data information simultaneously. It works by first establishing a voice link between stations.

As you may be aware, we speak in broken cadence, where there are comparatively long periods of silence between syllables and words. A DSVD modem has the ability to detect the silent periods on the voice channel, which are then stuffed with data packets in the same way *Windows* uses time slicing to "multitask" software applications. The dynamic data packet stuffing permits the data rate to reach speeds up to 28.8K bps during the silent periods.

Yes, you need a DSVD modem to communicate with another DSVD modem. Presently, only Hayes and US Robotics support this protocol. Will it become the protocol of the future? I don't think so. My guess is that the new FCC communications rules regarding the marriage of telephone and cable services will open up even better possibilities.

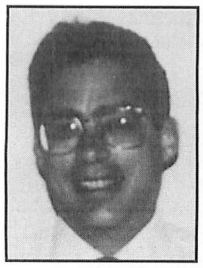
European Modem Services

Q. *I'm traveling to Europe this fall and would like to keep in touch with business, family and friends through e-mail. What will I need to connect to their telephone systems and which e-mail services provide the best international access?*—Thom, via America Online

A. Let's start with the e-mail issue. If you're currently on a service like America Online or CompuServe, you can dial up the service using a local European number. However, there's a by-the-minute surcharge that varies according to the country from which you're calling (expect it to be somewhere in the neighborhood of 20 cents per minute). The Internet, which is readily available in Europe, is another easy way to stay in touch with friends and family. The hardware side of connecting to e-mail is more complicated.

Generally, European telephone companies are owned by governments, and they're far more critical about the way you can connect to their services than is "Pa Bell." To paraphrase the UK phone system manual, "The only products which may legally be hooked up to the phone lines are those with a BT green sticker of approval." Buying the correct adapter can be tricky, though, because they aren't readily available in the UK, and those you can find are generally defective. Your best bet is to buy the adapters for the countries you plan to tour before leaving on your trip.

Finally, don't forget that all European power is 240 volts at 50 Hz, which won't work with your 117-volt, 60-Hz computer equipment. So you need a converter *transformer*, not a converter device like that sold by Radio Shack, of 200 watts or greater capacity for your computer to work. If you have access to the Web, I suggest reading the file "US to UK Moving FAQ" located at http://www.parmly-.luc.edu/sandell/ukfaq/uk_faq.html for more information on traveling through Europe. ■



By Joe Desposito

Computing on the Go

Recommending a $2,200 Notebook Purchase

One of the guys in the office next door, Bill, recently asked me for a recommendation on a notebook computer. He warned me right away that he didn't know too much about PCs and knew even less about notebooks. I groped for a good way to begin my response.

With a drawer filled with specifications dancing around in my head, I finally asked him how much he wanted to spend? "About $2,200," he said, then added, "I can go higher but I want to have some money left for a modem and a network adapter. By the way," he continued, "I want to use my cellular phone with the notebook. Can I do that?" I answered "yes" to this last question and then pulled out my Toshiba T3400CT for Bill to examine.

After describing the difference between a notebook and a sub-notebook (or ultra-notebook), I detailed the different features of the T3400CT. Then I told Bill to check out the selection at CompUSA and Computer City to get a better feel for the competition.

Bill followed my advice but, unfortunately, ran into an arrogant salesman. "He asked me which bus and which operating system I was interested in. When I said I wasn't sure, he told me to read up on portables and then come back." Bill was angry with the salesman, and rightly so. After all, I hadn't even bothered to mention to him about ISA, VESA and PCI buses, let alone warn him to stay away from Macintosh PowerBooks. (He uses a PC with *Windows* 3.1 right now).

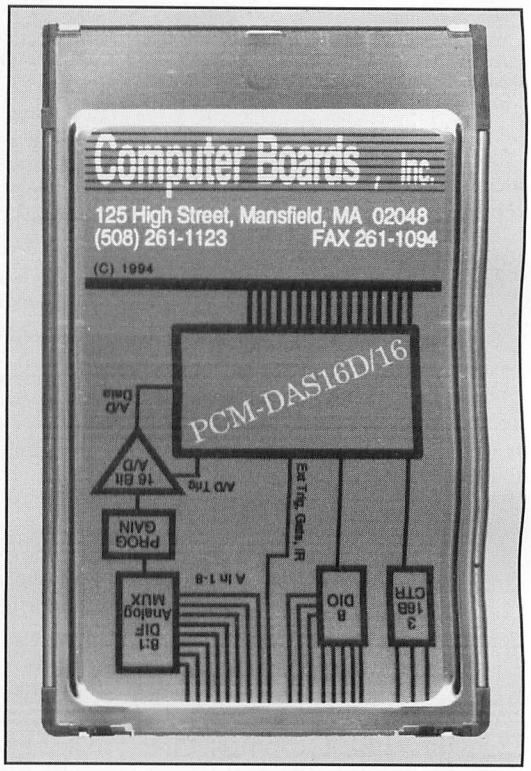
Bill still hasn't purchased his notebook, but he has forced me to take a good hard look at how to spend $2,200 or so on a notebook computer.

It may be instructional to review the factors that went into my decision to purchase the T3400CT. Cost was my major concern—I wanted to spend about $1,500. I preferred the ultra-notebook, which narrowed my choices considerably. As I reviewed the competing models (I didn't rule out notebooks altogether), I found that the display became the most significant factor after price. I wanted an active-matrix display, and I was willing to make some tradeoffs to obtain it.

I settled for less power than I had originally wanted (a 486SX-33 processor), less hard-disk space (120M) and less RAM memory (4M). The price for this model, which I got on sale, was $1,799. Eight months after purchasing this system, I'm still very happy with it, though I'm considering upgrading memory to 8M of RAM, due to *Windows 95*.

Since I've been very judicious in my use of hard-disk space, I haven't felt the need for a larger-capacity hard disk. If I do need more space, I'll most likely compress my hard disk and double its storage capacity, rather than purchase a larger-capacity hard drive.

I'll never get any more speed out this model, but it runs fast enough under *Windows for Workgroups* 3.11. If *Windows 95* makes the T3400CT operate unbearably slow, I'll probably re-install *WFW* and live with it for the time being.



ComputerBoards' 100-kHz PCM-DAS16/16 16-bit Type II PCMCIA PC Card is capable of resolving analog input signals to one part in 65,536 and is available in 16 single-ended or eight differential versions.

Now back to Bill's $2,200. The first question to ask is: Notebook or ultra-notebook? Bill wants to chuck his PC and use this portable as his main computer. For this reason, I recommended a standard notebook with a built-in 3½" floppy drive.

Now we move on to what I call the first tier of tradeoffs: processor, display, hard disk and memory. Naturally, you should consider the fastest processor available at your price. But if you think you'll get a $2,200 Pentium notebook for Christmas 1995, you're mistaken. A 486DX50, 66 or 75 is more likely in this price range.

Now on to the display. If you opt for an active-matrix display on a notebook-size computer, you drive the price past $2,200 without even trying. Still, there are a few models that offer 8.4" and 9.5" active-matrix displays for around the price target we've established (the larger 10.4" screen is, naturally, much more costly). Also keep in mind that I'm referring here to 640 x 480 VGA displays. Newer 800 x 600 SVGA displays are priced in the stratosphere right now.

Next is the hard-disk drive. As always, the larger the capacity, the better. However, tradeoffs usually will drive hard-disk storage down lower than you'd like. Let's figure on 250M as a minimum and look to obtain 340M or even 510M, if possible.

Finally, there's memory. If you intend to run *Windows 95*, 8M of RAM is Microsoft's recommendation, though most experts say 16M is preferred. But don't think you'll find a notebook with 16M of RAM for $2,200. Try to get 8M, and even take 4M as a potential tradeoff. Why? First of all, because it's easy to upgrade notebook RAM, you can always do it later when you save some money again. Also, you don't have to upgrade to *Windows 95* right away, especially if the rest of the slackers in the office are still using *Windows* 3.1. If you stay with *Windows* 3.1 for awhile, you can easily get by with 4M of RAM.

I found several notebooks that fit the bill using the first tier of tradeoffs as the deciding factors. These are listed in Table 1. I've included prices from two mail-order companies and from Computer City. My preference is the T4000M from Texas Instruments. Tradeoffs are minimal (4M of RAM) and the price is only $99 greater than the target price (from USA Flex).

Now I'll briefly run through some other important points to look for before making a final purchase. Let's start with battery life. Since Bill doesn't travel much, he expects to be near an ac outlet most of the time when using the computer. If you plan to often use a portable on a train or plane, you must investigate this feature much more thoroughly.

The pointing device is a consideration as well. I prefer a pointing "stick" over a trackball or finger pad, though I'll use an external mouse if the computing task demands it.

It's best if the connectors on the rear panel of the PC include serial and parallel ports, VGA, keyboard and SCSI, though getting all of these is usually not possible. A port replicator will generally add about $250 to the purchase price, while a docking station can add $500 or more. I'd stay away from both.

All portables have at least one PCMCIA slot nowadays, though it's probably better to have two. This isn't a big deal, though, since many PC Cards contain multiple functions, such as network adapter and modem or SCSI port and sound card.

Notebook keyboards generally aren't as good as standard types, though they aren't terrible. For heavy typing, though, it's nice to have a connector for an external keyboard. This isn't critical, since you can purchase keyboards that work through the parallel port.

Table 1. Portable PCs for About $2,200

Toshiba Satellite T2100CT
Processor: 486DX2-50
Color Display: 8.4" Active-Matrix
Hard Disk: 340M
Memory: 8M
Vendor: USA Flex ($2,647)

Toshiba Satellite T2400CT
Processor: 486DX2-50
Color Display: 8.4" Active-Matrix
Hard Disk: 320M
Memory: 8M
Vendor: Nationwide ($2,399)

Toshiba Satellite T2105CT
Processor: 486DX2-50
Color Display: 8.4" Active-Matrix
Hard Disk: 350M
Memory: 8M
Vendor: Computer City ($2,599)

IBM ThinkPad 755C
Processor: 486DX2-50
Display: 10.4" Active-Matrix
Hard Disk: 340M
Memory: 4M
Vendor: USA Flex ($2,569)

Texas Instruments T4000M
Processor: 486DX4-75
Display: 9.5" Active-Matrix
Hard Disk: 455M
Memory: 4M
Vendor: USA Flex ($2,299)

Texas Instruments T4000M
Processor: 486DX4-75
Display: 8.4" Active-Matrix
Hard Disk: 340M
Memory: 4M
Vendor: Nationwide ($2,099)

Texas Instruments T4000M
Processor: 486DX4-50
Display: 9.5" Active-Matrix
Hard Disk: 455M
Memory: 4M
Vendor: Computer City ($2,099)

NEC Versa V/50C
Processor: 486DX2-50
Display: 9.5" Active-Matrix
Hard Disk: 250M
Memory: 4M
Vendor: USA Flex ($2,224)

NEC Versa V/50C
Processor: 486DX2-50
Display: 9.5" Active-Matrix
Hard Disk: 340M
Memory: 4M
Vendor: Nationwide ($2,299)

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CIRCLE NO. 57 ON FREE INFORMATION CARD

If you're serious about running multimedia software from a notebook right now, forget about a figure like $2,200 and purchase a notebook with built-in sound and CD-ROM drive. If you plan to use multimedia sometime in the future, you can always spend the money at that point for an external CD-ROM drive and sound card.

Finally, the extras Bill wants—network adapter and cellular-ready modem—must be purchased separately. Many choices are available in the PCMCIA PC Card format. Cost is about $500 for the two, depending on features.

Upgrading Memory

With the advent of *Windows 95*, it's only natural to think about upgrading desktop and notebook computers to at least the Microsoft recommended 8M of RAM. I found that with my desktop 486/66, I was forced to purchase 8M of RAM to upgrade from 4M to 8M. Why? The 486/66 has only four memory expansion slots, which were filled with 1M SIMM modules. So I couldn't buy four 1M SIMMs. Instead, I had to buy two 4M SIMMs—at double the cost. Now I have 10M of RAM consisting of two 4M and two 1M units.

With the foregoing in mind, I checked the Toshiba Portege T3400CT. Luckily, it accepts a 4M, 8M or 16M module to upgrade the computer to 8M, 12M or 20M, respectively. The decision I make for this upgrade will be the final one, since there's only one expansion slot. With today's high prices demanded for RAM and the older processor of this 486/33SX ultra-notebook, I most certainly will opt for the $194 4M module.

PCMCIA Data Acquisition

The PCM-DAS16/16 from ComputerBoards, Inc. is a 16-bit Type II PCMCIA PC Card that's capable of resolving analog input signals to one part in 65,536 or 16 times the accuracy of 12-bit A/D cards. The 100-kHz PCM-DAS16/16 is available in two versions: 16 single-ended or eight differential. Software-selectable gains permit input signal ranges of ±10, ±5, 2.5 and ±1.25 volts bipolar. Sample acquisition triggering is performed by an internal pacer, externally or through software.

The PC Card features an advanced 512-word FIFO buffer and REPINSW command capability to ensure the transfer of large blocks of data with no missing samples. Three on-board 16-bit counters supply A/D pacing, event counting or frequency measurement. Eight lines of bi- directional CMOS digital I/O are configurable as eight in/eight out or four in/four out. Cost of the PC Card is $549. ■

Products Mentioned

Notebook Computers (see Table 1)
USA Flex (Mail Order)
Tel.: 800-888-2703; Fax: 708-351-7204
Nationwide
Tel.: 800-747-6923; Fax: 800-FAX-NWCD

CIRCLE NO. 153 ON FREE INFORMATION CARD

Toshiba T3400CT RAM Module
Worldwide Technologies
437 Chestnut St.
Philadelphia, PA 19106
Tel.: 800-636-6792; Fax: 215-922-0116

CIRCLE NO. 154 ON FREE INFORMATION CARD

PCM-DAS16/16
ComputerBoards, Inc.
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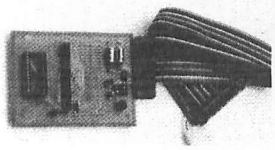

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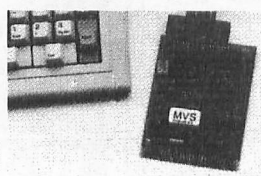

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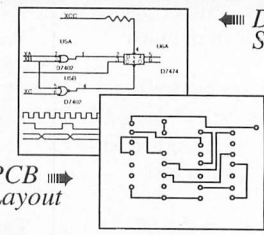

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CIRCLE NO. 101 ON FREE INFORMATION CARD

By Ted Needleman

Microcomputer Musings

ComputerEyes/1024 Color Video-Capture Card; Fargo's Photo-FUN! Dye-Sublimation Small-Format Printer; Server Technology's PC-Controlled Versa Timer

Now that the holiday season is upon us, it's time to start thinking about the gifts we'd like to receive—if only from ourselves. This holiday season, I report on two really appealing peripherals that anyone who works at a PC keyboard would love to have (I know I would) and a third item that puts a new slant on an old way of doing things.

Full-Motion Video Capture

For years, I've had the same video-capture card installed in my system. I've tested numerous other vendors' products, but I've always returned to my trusty ComputerEyes/RT card from Digital Vision. As much as I like the RT, it was designed in a time when single-frame video capture was the primary use for this type of peripheral. That may have been true several years ago, or even as late as last year. Today is a different story, though.

With multimedia taken for granted, and a range of terrific editing and presentation products available, full-motion video is fast becoming expected. And while the old /RT card can capture and create .AVI files, capture rate and resolution just isn't up to what's currently available.

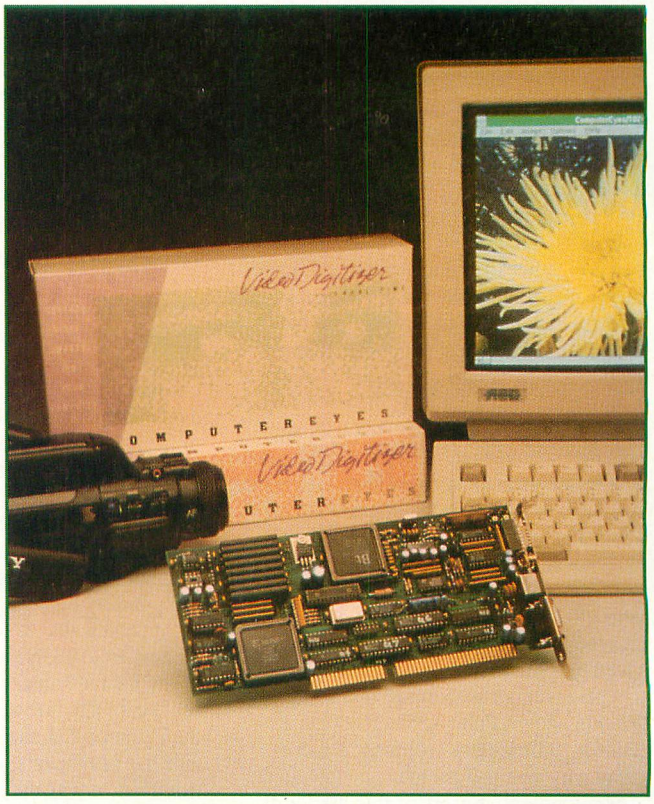
So good-bye, /RT. There's a new card in town, and it's taken the slot you used to have in my PC. Don't get too depressed, though. At least I'm keeping it in the family. Your replacement is Digital Vision's new ComputerEyes/1024, which was designed from the bottom up to be a high-performance video-capture device at a reasonable price. At $595 retail, it's not the least-expensive capture card around, but it's not the most expensive, either.

In terms of performance, the CE/1024 has a number of interesting features to recommend it. It offers (at least on paper) capture of full frames at the full 30-fps video most video devices use these days. In fact, if your video has lots of motion in it, you can capture individual fields (a frame is made up of two fields, each offset by one scan line). You can perform this capture at a variety of resolutions from standard VGA at 640 X 480 up to 1024 X 748 in full 24-bit color.

The card features three different inputs—standard composite through the familiar RCA-style phono jack, S-Video through a mini-DIN connector and RGB through a DB connector. Also on the side of the mounting bracket is a set of DIP switches, used to set IRQs, DMAs and I/O addresses. It's here that one of the most interesting features of the ComputerEyes/1024 comes to bear.

Installing many of today's full-motion video cards is frequently a daunting task. Full-motion cards are notorious hogs of system resources, and finding available IRQs, DMAs and address spaces within a heavily optioned system can often take hours—if, in fact, you can manage the task at all.

The CE/1024 offers two modes of operation. For optimum performance, you can use the DIP switches that are accessible from the mounting bracket to specify the system parameters the card should use. You can also do a quick-and-dirty install in what the vendor calls "compatibility" mode, and most of the time not have to touch the DIP switches to get the card up and running. The vendor admits that you may not



Digital Vision's new ComputerEyes/1024 video frame grabber offers 1,024 x 512 24-bit color capture.

obtain the full performance the card is capable of providing in compatibility mode but also claims that the performance loss will be minimal for most users when measured against ease of installation.

I have to admit that, other than the vendor's own parallel-port capture box, this was probably the easiest video-capture card I've ever installed. While running about 20 to 24 frames per second on most of the material I've captured, performance is sufficiently good in compatibility mode that I haven't as yet been tempted to fool around trying to squeeze the last bit of performance out of the board. I should also mention, that most of the video-capture cards I've tested that claim full 30-fps performance usually drop at least a few frames here and there. You can get actual consistent 30-fps high-resolution motion capture for professional uses, but you're going to have to pay a lot more for it than this or similar cards cost.

One place in which Digital Vision has consistently fallen short over the years is software. The hardware is great, but the utilities that accompany the card leave a lot to be desired. ComputerEyes/1024 comes with both DOS and *Windows* software to capture both individual frames and full-motion video. It can perform rudimentary filtering, such as sharpening and de-blurring, and save the video in various formats, including JPEG. But in these multimedia days, this is bare-bones, at best. Digital Vision recognizes this, advising that owners of the card will be best served if they also have some optional software, such as U-Lead's *Media Studio* or Adobe *Premiere*.

Both of the foregoing packages, as well as Asymetrix's new *Digital Video Producer*, are video-editing packages that permit you to capture video, edit it and piece together the edited video, even adding professional-level transition and other effects. Because Digital Vision includes support for Microsoft *Video for Windows*, all of these packages can directly work with the CE/1024 card. At the moment, however, there's no direct TWAIN support that would permit the card to be used as a frame grabber with an application like Adobe *PhotoShop* or Micrografx *Picture Publisher*.

You can, of course, use Digital Vision's utilities to make the actual frame grab, save the frame as a .TIF, .BMP or other graphic-file format and work with the saved graphic image in any package that accepts a supported format, including *Windows*' own Paint applet (though, except for rudimentary cropping, I don't know why you'd want to).

Many potential users of this card will already have the requisite software. If not, it's available from lots of places, and a close-out sale on a previous version, such as *Picture Publisher* 4.0, or *Image Pals* 1.0, will offer an economical path to very capable full-motion video.

Fargo's new Photo-FUN! photo-format dye-sublimation printer turns out superb color prints of photos.

Your Pictures Will be Ready Tuesday

It's not only full-motion video, like that available with the ComputerEyes/1024 capture card, that's making a big splash these days. Digital still photography is also starting to make a lot of waves. In addition to the Dycam camera I reviewed here a few issues back, Apple has out a new digital still camera, as do Chinon, Casio and even Kodak. Since all of these retail for less than $1,000, vendors must feel that there's a market for them.

One of the major problems with a digital camera, though, is output. Even when printed on glossy paper on a high-resolution printer like Epson's Stylus Color, the output still doesn't have the same "look" of a continuous-tone photograph. A number of digital-camera vendors offer "photographic" printers, but most of these are priced in the same $1,000 range as the cameras with which they're meant to be used. This is okay for serious professional use, but for home or casual use, getting high-quality output is still a big-ticket item.

At least it was before Fargo introduced its new Foto-FUN! printer. Fargo is best know for its Primera printer. Introduced a few years ago and upgraded last year to the Primera Pro, the Primera was first in a number of respects. At the time it was introduced, it was the first thermal wax-transfer printer for less than $1,000 at a time when wax-transfer printers were selling for $3,000 and more. A few months later, with the introduction of a $295 upgrade, this model became the first dye-sublimation printer for less than $1,300. Last year's Primera Pro replaced the original Fargo printer with a 300-dpi unit with both wax-transfer and dye-sub capability for less than $1,500.

Fargo was able to produce these milestone products by eliminating much of the expensive controller circuitry. These printers require that the rasterizing and imaging be performed on the PC with which they're used, rather than within the printer itself.

With its newest printer, the Foto-FUN!, Fargo has applied its expertise in thermal dye-sublimation to create a specialized printer for producing digital photographs. The Foto-FUN! is a small 9.625" X 4.25" X 7.5" printer that weighs a hefty 7 pounds. This 203-dpi dye-sublimation printer interfaces a computer through either a standard parallel port for *Windows*-based PCs or a serial port for Macs. It uses a special 36-image dye-sub ribbon, and 4" X 6" paper or heavy picture-postcard stock.

Both the standard "photo" paper and postcard stock cost about $1 a print (the photo and postcard stock sell for $34.95 and $39.95, respectively, for 36 prints). This is a bit expensive when compared with drugstore photo developing, but it's not out of line when compared to Polaroid instant photos. As the printer and supplies make their way into the mainstream, prices should come down substantially, though.

Fargo also offers a FotoMUG! kit. This consists of four mugs and a special clamp that lets you transfer your photos, when printed, to the surface of the mugs. At

$29.95, this kit won't be for everyone, but at just short of $7.50 each, custom picture mugs might be a fun item to produce. I received one of the first Foto-FUN! units off the production line, and neither the postcard stock nor the mugs were available at the time. I'm expecting both soon, and I'll let you know how they work in an upcoming column.

Setting FotoFUN! up takes about 5 minutes. You unpack it, plug in your printer cable and the power supply, insert the ribbon and install the software. The software installs like most printers through the *Windows* Control Panel. Settings on the printer driver are rather sparse.

Paper-size selection offers two choices. Actually, the paper is the same size for both, which is 4" X 7.7". If you select "Borderless," you can print an image of up to 4" X 6". The second option, "Border," places a 0.2" black border around the image, reducing maximum print area to 3.6" X 5.6". Other driver options allow you to use Fargo's Color Match system and set portrait or landscape mode. There's also a choice labeled "Overlay." Unless you're printing photos to be transferred to mugs, this choice should always be selected, as it uses a fourth ribbon panel that places a transparent overlay over the picture to enhance the printout's durability. Finally, there's choice for "Mirror Image," which flips the image when you're printing mug transfers.

Using the printer is a snap. After turning it on, just select it and print to it as you would any other printer. Since Fargo doesn't supply imaging software, you'll need some type of draw package to manipulate, edit and print your photos.

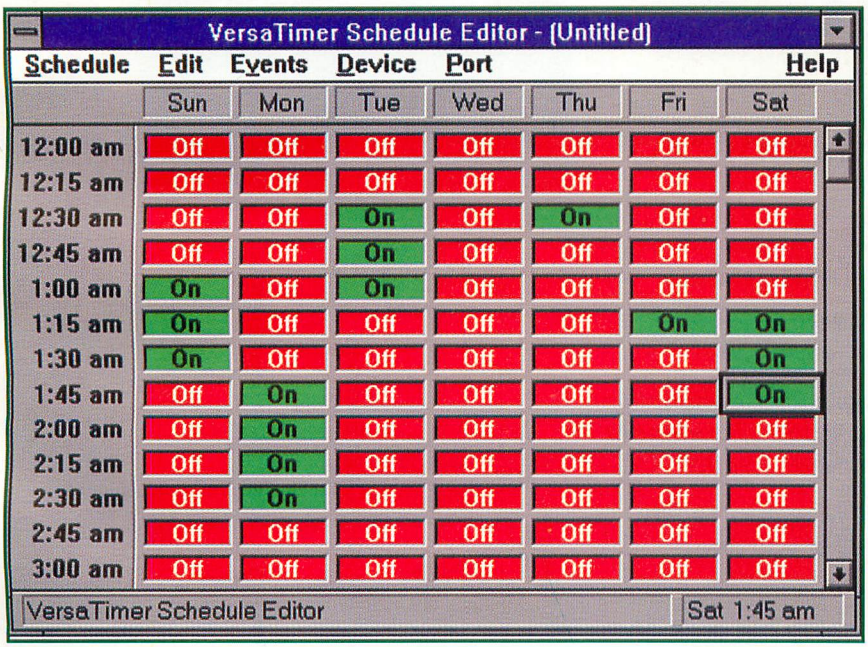
I tested the printer using *Picture Publisher*, *Image Pals*, *PhotoShop*, *CorelDRAW!* and *Corel PhotoPaint*. All work great with Foto-FUN! After issuing the Print command, you insert a piece of the special paper, glossy side down. After about two or three minutes of ruminating, the photo prints in about a minute.

Photos I printed looked absolutely great! The printer is rated at a resolution of only 203 dpi, as was the original Primera from Fargo. But it's important to keep in mind that this is a dye-sublimation printer and that the output approaches continuous tone. In fact, even without me playing with the images in the above packages, the photos I printed look like photos, not like computer printouts.

I was impressed several years ago with Fargo's original Primera printer, but Foto-FUN! is a real knockout. If you're playing around with digital photography, whether with a frame grabber or digital still camera, you *need* this printer! In fact, if *Microcomputer Journal* had an Editor's Choice Award, Foto-FUN! would, hands down, get my vote. It's the first affordable digital photo printer, and it works just great.

Time is on My Side

I don't go on vacation all that often, but when I do, I always have to hunt around for one of the old electric timers I keep in the basement. You know the ones I mean, with a round dial and those little pins you use to set the time the device turns on and



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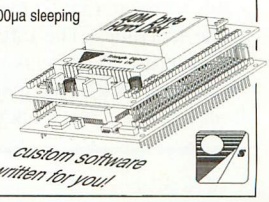

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off. If you haven't lost the pins, they're pretty easy to use. Just plug a pin into the dial when you want an appliance or light to turn on and another one at the time you want it to turn off. Then plug a lamp or other device into the timer, and the timer into an ac socket.

Assuming you've set it up properly, every night at the same time, your light will go on, and every night at the same time, it will go off. That is, if you don't have a power failure while you're away that throws the whole thing off schedule.

Last time out, I tried something new, VersaTimer from Server Technology. VersaTimer is just that, a versatile electronic timer that can control up to three devices plugged into its switched ac power outlets, though not separately. What makes VersaTimer really different and interesting is that you program it from your PC's serial port.

Instead of little pins that get lost each time I dump the timer into the basement, VersaTimer comes with DOS and *Windows* software that let me create, save and reuse schedules. The software couldn't be easier to use. It presents you with a grid of the entire week, broken down into half-hour intervals. Just click on an interval, and the box turns from red to green, indicating an ON condition for the outlets.

VersaTimer is a seven-day device. If you're away longer than this, the programmed cycle repeats itself. And you don't have to worry about a power failure because there's a 9-volt batty backup that holds your schedule in memory for three days. If a power failure lasts longer than this, you have bigger problems than a device that turns on and off your lights or other appliances.

VersaTimer has another neat feature. You can set it up as a "smart current outlet." This mode lets one device act as the on/off switch for the other devices attached to the remaining outlets.

Obviously, $100-plus is a lot to spend to turn on and off lights. After all, $5 InterMatic timers work pretty well in this application. The real value of VersaTimer is turning on and off your PC while you're away. I've taken to hooking up my office PC to a VersaTimer when I'm traveling. At varying times, on a schedule I select, my PC is powered up, with the modem waiting for my phone call. I can download new files and upload files I may have forgotten.

Server Technology has devices specifically to turn on your PC when a phone call is received via a modem, but I find VersaTimer an acceptable (and less-expensive) alternative. It's an alternative I can also use to turn on and off the lights when we go on vacation. ■

Products Mentioned

ComputerEyes/1024, $595
Digital Vision, Inc.
270 Bridge St.
Dedham, MA 02026
Tel.: 617-329-5400

CIRCLE NO. 130 ON FREE INFORMATION CARD

Foto-FUN!, $400
Fargo Electronics, Inc.
7901 Flying Cloud Dr.
Eden Prairie, MN 55344
Tel.: 800-327-4690

CIRCLE NO. 131 ON FREE INFORMATION CARD

VersaTimer, $109
Server Technology, Inc.
1288 Hammerwood Ave.
Sunnyvale, CA 94089
Tel.: 408-745-0300

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By Yacco

GUI Guts

Ho ho ho!

It's that season again! Since this is the year of *Windows 95*, what's left of it, you'll probably want your computer gifts to have some tie-in. It's a good idea. The transition is going to gobble new resources faster than a hungry man consumes a holiday dinner. Recipients of your largess will appreciate whatever help they can get.

Memory products are going to be at the top of the list. Though *Windows 95* is claimed to require a minimum of 4M of RAM to run, unless you just want to watch the wallpaper, you'll need 8M to run an average application and at least 12M to run more than one application with acceptable performance.

A second requirement for anyone who is planning a *Windows 95* upgrade is hard-disk storage. You might use half of your old 100M drive just for a complete system installation. Don't expect new applications to get smaller, either. You should plan on developers taking increasing advantage of the opportunities this system offers. New applications are likely to swell their megabytes in proportion to any upgrade you can afford.

Some users will also be looking for video and/or multimedia upgrades. One of this system's few advantages over *Windows NT* is it's multimedia support. *Windows 95* also promises to run DOS games better than DOS did. A large video monitor, high-speed video card and CD-ROM upgrade are good choices.

You'll want to consider several factors when you perform the analysis to determine if a system should be retained. One of these factors should be how many improvements are required. It might make sense to add memory, a new video system, a CD-ROM drive or a new hard drive. However, you should price some new systems if you consider adding several of these enhancements to an older machine.

Memory, storage and multimedia upgrades are good choices for many systems. However, older machines may require more basic improvements. In most cases, computers that have slow processors should just be replaced with new multimedia systems. This question should be foremost among those you ask. There's not much point in buying improvements for a machine if they're not likely to give you the end result you seek, which is good *Windows 95* performance.

You should carefully scrutinize additions to computers that you won't eventually be able to port to a replacement machine. Hard-disk and CD-ROM drives are the most likely to be portable. Video systems have a fair likelihood, as well. Memory will depend on more design issues. Don't expect it to be a good candidate for any new system you might buy.

There are a few possible exceptions among older systems that may warrant more upgrading than average. A computer that's already received many piecemeal upgrades may be sufficiently rehabilitated to merit minor enhancements. You should also consider how replacement peripherals increase the cost of a new system. You'll have more incentive to keep a system if replacing it would mean replacing many expensive peripherals as well.

Many PS/2 systems could very well fall into the latter category. Almost nothing from a PS/2 is likely to go into a replacement unless it's another PS/2. Current system designs have bypassed the MicroChannel.

Fortunately, many corporate users are upgrading the 8- or 10-million MicroChannel machines that have already entered the market. So, there are several good sources for PS/2 enhancements. Two vendors with processor upgrades are Kingston Technology and Reply.

The Kingston processor solution has cost and installation advantages. It's a simple processor replacement. You remove the existing 386DX processor and replace it with the Kingston Technology Lightning 486/BL66 processor board. This board has a surface-mount IBM 486DLC processor with 16K of internal cache, as well as the necessary "glue" chips. The 486/BL66 turns a 386 PS/2 running at 16, 20 or 25 MHz into a 66-MHz 486. It continues to use the 387DX math coprocessor, if one is present, without the use of device drivers. In fact, no device drivers or other software are required for either operation or installation of the Lightning 486/BL66.

Kingston's kit also supplies all the materials you need to install your board into any of three types of PS/2 Model 70 and three types of Model 80 computers. A 132-pin PGA socket extender is provided for use with systems that Kingston identifies as Model 70 Types II and III and Model 80 Type II. The kit also includes a simple extractor tool for removing the old processor, a utility diskette and an exhaustive installation guide.

The guide has both illustrations and instructions to help you determine which type of motherboard your system has. Other illustrations help you to properly orient the upgrade. The only other items you'll need to complete your installation are the IBM Reference diskette that came with your system and disassembly tools.

Note that disassembly requires removing adapters, and on some machines removing the hard-drive assembly as well. After you replace your processor, you'll have to use the Reference diskette to re-configure the system's CMOS. If you don't remember where that diskette is anymore, don't worry. All the PS/2 reference diskettes from series 25 through 95 are available in Library 2 on IBM's PS/2 CompuServe forum.

The 486/BL66 has several DIP switches. If software or hardware configurations conflict with the processor board's cache, these switches can temporarily disable it. Most systems won't require any other setting changes unless they're running a bus-mastering adapter. The kit's utility diskette includes a routine for changing cache speed through software and a copy of the Landmark speed test. Kingston's tests on a Model 70-161 showed an improvement from 23.64 to 153.16 MHz.

Of course, Kingston is also a major source of memory upgrades, which it has for a number of PS/2 models. The KTM-MC64 adapter fits PS/2 Models 70, 80, 90 and 95. Two versions of the board, the KTM-MC64/4 and KTM-MC64/8, come with one 4M or 8M module pre-installed, respectively. However, the basic board supports four modules that total up to 64M of RAM. You can use 2M, 4M, 8M or 16M modules and install them in the sockets in any order.

Kingston provides a thorough manual and a utility diskette, but not much effort is required of you. System configuration is automatic. About all you have to do is make a backup Reference diskette that includes some data from the Kingston utility diskette.

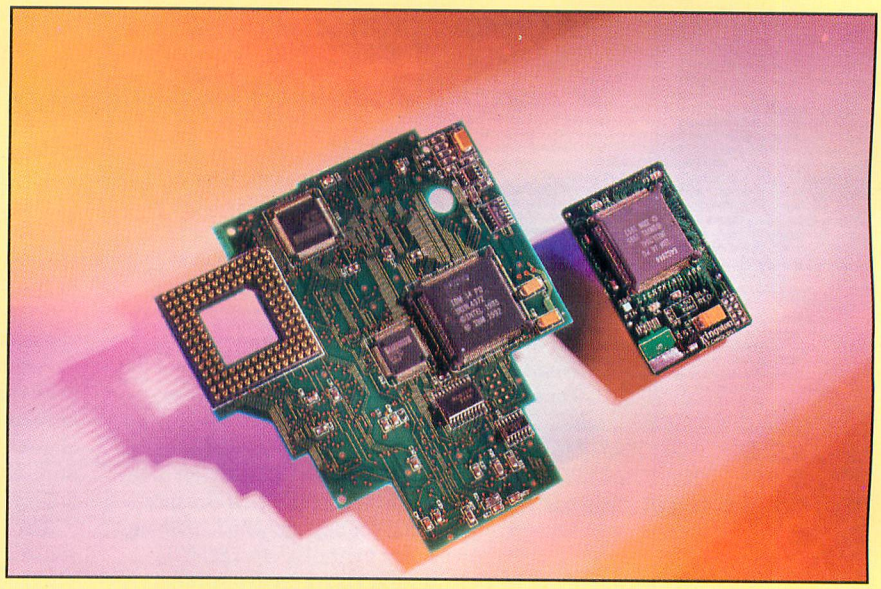
Reply's processor solution requires removal and replacement of the entire motherboard. It's also a more-expensive part than the Kingston processor board. However, this solution does offer the advantage of a faster and wider bus, 64-bit video and support for a SCSI hard-disk upgrade.

Reply has a wide array of PS/2 upgrades in addition to motherboards, including video and multimedia systems. The company claims its $195 SVGA Micro Channel Video Accelerator increases performance 450% over IBM 8514 adapters and 79% over XGA adapters. It comes with 1M of 70-ns DRAM, a 16-bit Micro Channel interface and a three-year warranty. Drivers for OS/2, *Windows* and DOS are included to support 10 resolutions up to 1,280 x 1,024, VESA-compatible modes and refresh rates up to 72 Hz.

The multimedia system Reply offers for the PS/2 is similar to those you might buy for any computer, except it's for the MicroChannel architecture (MCA) bus. The company has several different kits ranging from a $295 sound card to an $895 kit with a quad-speed external CD-ROM drive, SoundBlaster Vibra 16 sound card and pair of self-powered Altec-Lansing ACS5 computer speakers. Kits with internal CD-ROM drives are $200 less, and a double-speed drive cuts another hundred off either configuration.

The 16-bit Reply sound card (available with or without SCSI connector for CD-ROM drive) supports recording and playback, selectable sampling rates, audio dynamic filtering, true 16-bit stereo for 44-kHz files, 20-voice OLP3 stereo FM synthesis, stereo digital mixer, full software control of 10 channels, MIDI interface, microphone automatic gain control (agc) amplifier, wavetable upgrade connector and support for ADPCM and CCITT A-Law and u-Law. It also supports eight-bit recording and playback.

The multimedia kit also contains a Future Domain SCSI-2 controller, *PowerSCSI!* software and a CD-ROM drive. The double-speed drive offers 360K/s data transfer rate and 220-ms random access speed.



Kington's Blue Lightning 486 for PS/2 Models 70 and 80 (left) and Blue Lightning 486 for PC/compatibles (right).

Reply ships the kit with audio and SCSI support programs, as well as some sample applications. Audio software includes Creative Labs' Wave Studio, Ensemble AV, and Sound O'LE, Mixer. SCSI support includes the MCS CD Master, *ImagePals* 2LE Album and the Corel ISO driver. The bundled software includes Microsoft *CD Home Sampler* and a Great Bear title, such as *Portraits of American Presidents* or *Medical Advisor*.

Crystal Computer's Crystalizer PnP card provides a very-flexible sound and CD-ROM controller for ISA-bus computers. There are four versions of the card. The Multi CD version provides interfaces for drives from Mitsumi (Models LU005, FX001 and FX001D), Panasonic (Models 522, 523, 562 and 563) and Sony (Models CDU 31A and CDU 33A). The SCSI-2 model provides these three interfaces in addition to SCSI-2.

Both models are also available in a Plus configuration that comes bundled with the Microsoft Sound System and a Koss M/11 microphone. Crystalizer PnP installation is automatic in Plug and Play PCs. Quickstart auto-configuration software guides you through installation in legacy machines.

Sound cards work best with shielded computer speakers, such as the ones bundled in the Reply kit or the new $339 Bose MediaMate Computer Speakers. MediaMate speakers provide excellent bass response, even at low volume levels, and avoid introducing distortion as you crank up the volume. All controls are front-mounted for easy access, and there's even a headset jack for private listening. MediaMates are ideal with a sound card like the Crystalizer, with a kit like the unbundled version of the Reply multimedia kit, or as an upgrade for any old pair of tinny speakers you might have.

You can also get simple CD-ROM drive kits if your only interest is access to database and software-distribution CD-ROMs. The Vertos 300 SSD is a serviceable, yet inexpensive, double-speed internal IDE/ATAPI drive from Elitegroup, an OEM provider of system boards and peripherals to some of the industry's leading computer vendors. In systems that have an IDE hard drive, it has the low cost advantage of connecting to the drive controller without requiring a separate SCSI card.

Front-panel controls include an earphone jack, volume control and play/pause, stop, next track, previous track and eject drive controls. Random average access time for the drive is 350 ms, and data transfers at the standard 300K/s double-speed rate. Drivers, an installation manual and mounting hardware are included.

Final *Windows 95* Caveat

If you find that you're overwhelmed by the hardware requirements for *Windows 95*, you might want to put off your purchase. There aren't many reasons to rush into *Win95*, and there may be a few advantages to delaying.

Here are a few of the reasons you might

want to wait. *Windows 95* has some impressive interface improvements that will make it easier for new users to learn and use their computers. Experienced users, though, already know their current edition of *Windows*. For you, it will require more training, not less.

Windows 95 also has some productive new features, such as built-in PC Card drivers and a Winsock (TCP/IP protocol stack). Plug and Play support is integral to *Windows 95*, as is a 32-bit architecture.

Unfortunately, the PC Card drivers in *Windows 95* are representative of two-year-old technology. They don't work nearly as well as the latest generation of drivers from companies like Phoenix, Award or even SystemSoft—the company that wrote the drivers Microsoft chose for *Win95*. You'll eventually be able to buy driver upgrades that will replace the ones in *Win95* directly from these companies. Until you can, of course, the *Windows 95* drivers represent another reason to wait.

As for the Winsock, there's the question of what you can do with it. The Microsoft Network isn't much more than an infrastructure, and it isn't very stable yet. Microsoft is reported to be addressing this, in part, by initially limiting membership. When you look at the infuriatingly sluggish service that AOL users have had to endure during its rapid growth, this is obviously a good policy.

It's good for users who get on early, that is. If you're not able to get in before the cutoff, you'll have to wait to use this feature—whether or not you have *Windows 95*. Moreover, Microsoft Exchange is still little more than an attractive e-mail client. The workgroup features that were once touted as a competitor for *Lotus Notes* certainly aren't in this version of Exchange, at least not in the part that's included in *Win95*.

Windows 95 has significantly improved it's own installation, and it even includes a utility (Wizard in Microsoft parlance) to help you install and uninstall applications. But Plug-and-Play support will have to wait for hardware vendors to incorporate the standard into their machines.

In the same way, the system's 32-bit architecture must wait for developers to write new applications before you'll receive it's benefit. In fact, your 16-bit applications will become especially difficult to use unless you add a product like Vertisoft's *Name-It*. Without *Name-it*, you can either wait for upgrades or forego long filenames.

The problem is that long filenames created by 32-bit applications will be especially meaningless in 16-bit apps. You'll see only the 8-dot-3 character name *Windows 95* creates to ensure they're unique for the DOS directory system. (Yeah, the DOS directory and FAT are still there.) And since *Windows* cobbles these from the long names according to a terse alphanumeric algorithm, you'll find them more difficult to use than ever.

Fortunately, *Name-It* runs in the background and replaces 16-bit dialog boxes with a 32-bit dialog that lets you use meaningful names in all your applications. It also creates a history log to help you find the last 150 files you've accessed. A utility called History lets you sort and view them.

Conclusions

I was very amused to see Bill Gates on the news talking about *Windows 95* the day before his big Redmond roll-out party. He said *Windows 95* was designed in response to the things that users disliked about *Windows* 3.x. The funny part wasn't what he said, but its subtext. Every point he made for *Win95* was, in effect, an admission of the failures in the current product. It makes you wonder what great *Windows 95* enhancements you'll be reading about in a couple of years. From what I've seen, it could be many of the same things.

Regardless of the foregoing, you have to give *Windows 95* its due. Whatever it's limitations and drawbacks are in the short run, *Windows 95* will mean a much better computing environment in the long run. This isn't just because of the changes in *Windows* itself. They're noteworthy, but not revolutionary, despite the hype. (If you don't believe me, just ask any Mac user.) The system's real impact will be felt over the next few years when developers produce the new applications that widespread computing power enables.

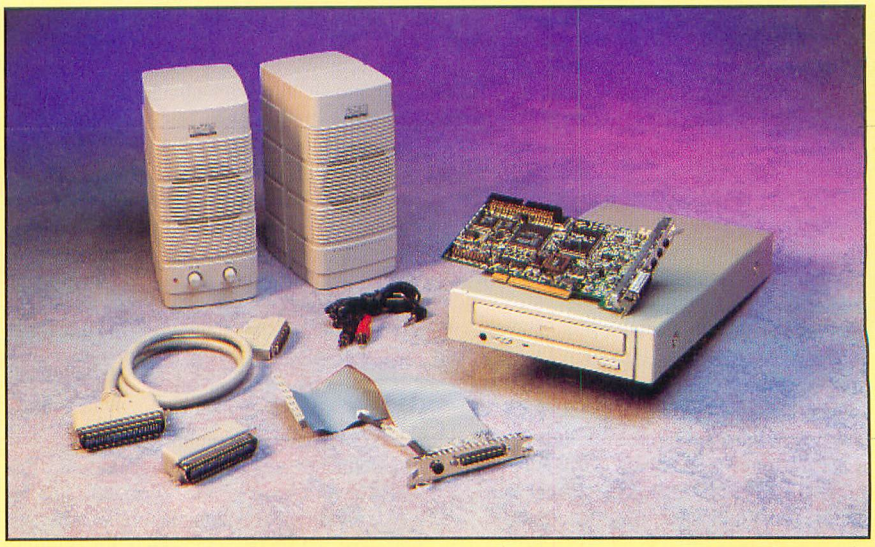
The type of installed hardware base that *Windows 95* is instigating will eventually lead to development of things like continuous-speech recognition suitable for dictation. There's no way of knowing at this juncture what some of the new applications might even be. But you can bet developers are going to take advantage of all the increased horsepower, just as surely as they'll be writing 32-bit apps that take advantage of multithreading, multitasking, OLE, networking, multimedia and the Internet. The *Windows 95* conneffling blivit will framis the pestarus and ramallam the mandulator. As for myself, I'll consider the expense of this transition a worthwhile investment if its only outcome is to finally dismantle the elitist culture of those insufferable Macintosh snobs.

Software

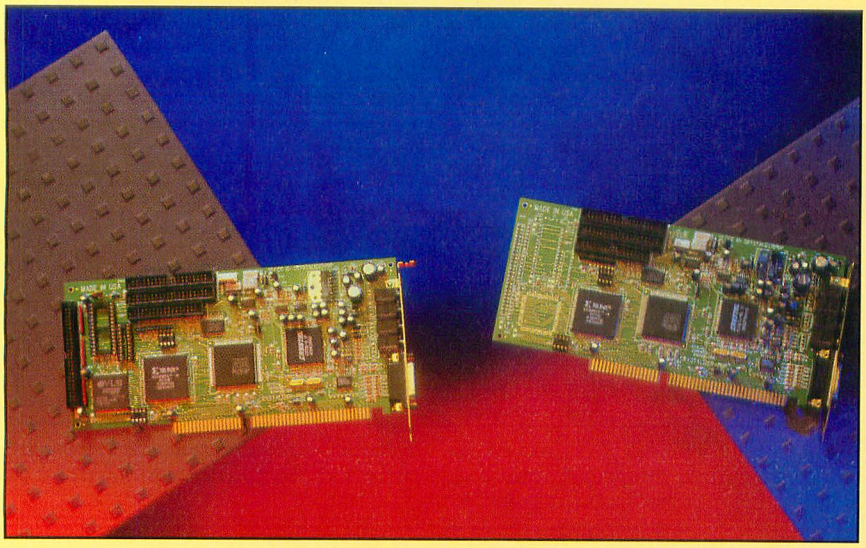
For the past year or two, my holiday software picks have concentrated primarily on "edutainment" titles. This year, however, I'm going to continue with the *Windows 95* theme.

A few software products began shipping shortly after the gold beta for *Windows 95* arrived. I already have the *Norton Utilities*, *Norton Navigator* and *Norton AntiVirus for Windows 95*. Utilities are probably going to be among the first products you'll want to buy when you get *Windows 95* because your old ones are likely to range from largely incompatible to dangerous. Furthermore, even if your old virus software seems to run fine under *Win-95*, it's not designed for *Windows 95*-specific viruses.

The new operating system creates opportunities for at least three new types of viruses: OLE2 viruses that mimic OLE2 servers, viruses that capitalize on the ex-



Reply's multimedia system for PS/2s is similar to systems for PC/compatibles, except that it's designed for use in MCA systems.



Crystal Computer's Crystalizer PnP provides a flexible sound and CD-ROM controller for ISA-bus computers. Four versions are available.

tensibility of the shell in *Windows 95* and VxD viruses that potentially have the same privilege level as the kernel and can bypass any protection mechanism whatsoever.

Windows 95 is going to make the Intel-powered PC a much better platform for desktop multimedia, video and publishing. Corel representatives tell me that *CorelDRAW!* 6 went into production a week ago at this writing in late August. (Corel announced on August 29 that its *CorelDRAW!* 6 was on store shelves of that date.—*Ed.*). Adobe is planning to ship 32-bit versions of *PageMaker* and *PhotoShop* for *Windows* within 90 days of the release of *Win95*. The company is also working with Microsoft to integrate *PhotoShop*, *Illustrator* and *Acrobat* into the forthcoming interactive application publishing platform, code-named "Blackbird," for the Microsoft Network's on-line content providers. Blackbird will create applications that are optimized for low-bandwidth delivery of rich interactive multimedia content.

You might consider an image collection for the desktop producers and publishers on your shopping list. HSC and Corel have both introduced huge collections of photographs on CD-ROM.

The *KTP Power Photos* collection from HSC was specifically created to provide images commonly used in advertising and graphic design. The set includes five volumes on 10 discs: Natural Backgrounds and Textures; Food Basics; Urban Textures and Backgrounds; Sky, Water and Landscapes; and Sports and Recreation. The 500 images include barbed wire, graffiti, road signs and others that can't be found in typical collections.

Files are provided in high-resolution 18M to 24M RGB TIFF format and also in a sample catalog of RGB TIFF thumbnails. Many have masking channels. These are all high-resolution full-color images that are suitable for any amateur or professional application. Furthermore, each was photographed specifically for the series and is provided royalty-free. Put them into advertising, packaging, the cover of a book, or a Web page without paying additional fees. A single-disk version of the Kodak Photo-CD Browser is included, too.

The Corel *Stock Photo Library* is by far the larger of the two collections. In fact, it's a monster. There are 20,000 photographs on 200 CD-ROMs in the complete set. And as if this weren't enough, Corel has already produced a second 20,000-image set called *Stock Photo Library 2*. The complete libraries list for $1,598 each, but the discs are also available for $17 individually, or in 25-disc volume sets for $149 per set.

These 18M PhotoCD images are also royalty free for any use, except for sale as images. As with the HSC images, you can put the Corel images in whatever you want. Corel's Photo CD Lab, which is included on each disc, provides a viewer and lets you perform format conversions for use in popular applications.

Quality like this was once available from only photographic libraries and subscription services. You had to look through catalogs, order the artwork and wait for it to be delivered. You also had to pay an additional fee according to how you used the image and how many people would see it. Now you can have photography of the same caliber sitting on your

Companies Mentioned

Lightning 486/BL66, $335; KTM-MC64/4: $385 (also for AT&T Models 3445 and 3447); KTM-MC64/8, $655 (also for AT&T Models 3335, 3345, 3445 and 3447)
Kingston Technology
17600 Newhope St.
Fountain Valley, CA 92708
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Discwasher CD-2, $9.99
Recoton
46-23 Crane St.
Long Island City, NY 11101
Tel.: 800-742-3438

CIRCLE NO. 128 ON FREE INFORMATION CARD

desktop. The convenience alone is worth the small price per image.

Stocking Stuffers

The CD-ROM is a hardy medium. Magnetic fields don't bother it at all. You can drop it from significant heights without breaking it, and you'll never trash a read/write head. It's also much more dependable and longer-lived than tapes. In fact, data stored on CD-ROM should last for many decades, if not centuries. However, the CD-ROM do has one weakness. Its surface is constantly exposed to dirt and abrasions that can interfere with the laser energy that reads them. Fingerprints, dust specks and scratches can cause the appearance of extraneous data, as well as complete read failures.

CD-ROMs are difficult to break, because they're manufactured from polycarbonate, the extremely resilient material used to make bullet-proof "glass." Nicks and minor scratches, however, are common.

Last year, I suggested giving the Discwasher HydroBath as a stocking stuffer. It's ideal for removing all sorts of grime that might cause data errors, but it can't do a thing about abrasions. This year, I'd like to recommend another Discwasher product that can resurrect damaged discs and bring data back from the grave.

The Discwasher CD-2 system consists of a polishing agent and a cleaner, swabs and soft wipes for application and polishing. You apply the polish using either the swabs or a clean finger. After the compound dries, you buff it with the wipes. Small scratches just disappear. Larger scratches take more work, but if they're not too deep, they'll come out, too, with multiple applications. In the final step, you remove the residue with either the wipes and cleaning solution or the HydroBath.

Once the process is complete, you have a pristine, highly polished disc. A single restoration could save you hundreds of dollars if the scratch was causing your CD-ROM to malfunction.

Incidentally, despite what the instructions on the HydroBath cleaning solution state, a company representative recently told me that you don't have to throw it out after each use. According to the representative, with whom I spoke at the Electronic Entertainment Exhibition in Los Angeles, it contains a bactericide that preserves it for approximately a hundred cleaning cycles. Recover it from the drain hole immediately, and store it for future sessions.

Yacco can be reached at yacco@earthlink.net and is yacco@compuserve.com

Bits 'n' Pieces **By Alexander W. Burawa**

Windows 95 Books

At long last, *Windows 95* has arrived, and it's so different from what even old hands at using *Windows* 3.x are used to that it will take a bit of time to become familiar with its conventions. Since the only hard-copy "manual" that comes with it is strictly bare-bones information on how to install it on your PC and the rudiments of using it, a plethora of after-market books, all claiming to teach you how to use *Windows 95*, have hit the market. So far, Microsoft Press seems to be in the van with these new books, with multiple titles announced weekly. Two Microsoft Press titles that have come my way are worthy of note. One is the *Field Guide to Microsoft Windows 95* (soft cover, 187 pages, $9.95) by Stephen L. Nelson and the other is Microsoft Windows 95 Step By Step (soft cover, 277 pages, $29.95).

The *Field Guide* is one of those books you'll want to have handy as you become acquainted with *Windows 95*. It's basically a reference handbook. Following a brief introduction that tells you what the *Guide* is all about, the book gives you a tour of the new *Windows 95* environment. The latter is accomplished via a series of *Win95* screens with call-outs to various displayed items and minimal explanatory text—not that you need much with this new OS. Here you'll find out how to start applications and run multiple apps. You're also introduced to *Win95*'s system tools, managing windows and using menus and commands. This section closes with *Windows* Explorer, which lets you look at the way your computer system is organized and what's connected to it. Like the operating system itself, the *Windows 95* Environment section of this book is graphics-intensive. Through screen illustrations, you get a brief tour that gets you up to speed in no time flat.

Most of the rest of the book is titled *Windows 95* A to Z, which consists of an alphabetical listing of the tools, terms and techniques you'll use in your day-to-day operations on your PC under *Win95*. This is little more than an expanded glossary of terms and their definitions, most of which you'll already be familiar with but some of which are *Win95*-specific and should be learned.

Next comes a Troubleshooting section, all 18 pages of it. The idea here, I guess, is that not much can go wrong with *Windows 95*. Therefore, this section covers only the more-common problems you may encounter, like not being able to get an application to respond, not being able to print, not being able to save a file onto a disk, etc. Actually, the problems covered here are more or less the ones anyone who uses *Windows 95* is likely to encounter. Problems that aren't covered are most likely hardware and/or software-specific, for which you'll need much more technical help than this *Guide* is designed to provide.

A Quick Reference section closes the *Guide*. The objective of this section is to provide the shortcut keyboard combinations for the Start Menu Guide, *Windows* Explorer and My Computer Menu Guide, Printers Folder Menu Guide and Printer Menu Guide.

All in all, this is a worthwhile reference book to have. I'd call it a "handbook" because of its compact size, but it's not so compact that it will fit comfortably into a pocket. Even so, it's compact enough to sit unobtrusively beside your PC, where it will always be handy for a quick look-up.

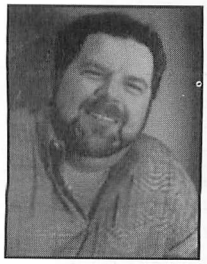
Bear in mind this is a basic book and that in a relatively short time using *Windows 95* you'll become familiar enough with the operating system to rarely have reason to refer to it. So why buy it? The answer is that it can ease the transition to this new operating system—and at $10, the price is right.

As its title implies, *Microsoft Windows 95 Step By Step* is an interactive tutorial. It consists of 12 lessons you complete to get you up and running and make you a power user. Supplied with the book is a 3½" floppy diskette that contains the files you'll use interactively while completing each lesson. (You must have *Windows 95* installed on your PC to use these lessons.)

Once you've read the Getting Ready section at the beginning of the book and have loaded the software from diskette onto your PC, you're ready to begin with Lesson 1, where you'll be working with the desktop tools. Here, you'll learn the basics, like controlling window elements with your mouse, giving commands with your mouse and menus, specifying options and properties in dialog boxes and moving and re-sizing windows on the screen. Lesson 2 continues with the basics, guiding you through locating and starting documents, activating and controlling documents using the taskbar and looking up topics and learning about *Windows 95* using on-line help.

Having mastered the basics, you move on to Lesson 3, where you learn how to access frequently used programs by adding commands to your Start and

(Continued on page 99)



By Tom Benford

Multimedia

An Ergonomic Keyboard; a Surge Suppresser; Multimedia Products; and more

This time around, I report on a range of products that cover a wide area of interest. As you can see from the title of this column, several of these items are directly related to the subject of multimedia. Two others are of interest to anyone who uses a PC.

Natural Keyboard

I admit that I was more skeptical than curious about Microsoft's Natural Keyboard when I first received a review unit. When I started using it, I didn't think I'd ever get used to it. But I'm here to tell you that Microsoft has made a believer of me!

Some studies suggest that long periods of repetitive motion, coupled with an improper work environment and incorrect work habits, may be linked to certain types of physical discomfort or injury. These include Carpal Tunnel Syndrome, tendonitis and tenosynovitis. Perhaps the best known of these is Carpal Tunnel Syndrome, or CTS. This a painful and chronic condition that plagues many folks these days of personal computing.

CTS results from keeping the hands in a cramped position for long periods of time. Many PC users who spend hours on end at their keyboards while entering data are at substantial risk and likely candidates to become victims of CTS. Several accessories companies have started marketing wrist-rest pads to lessen the strain caused by keeping the wrists elevated above the keyboard. These are, indeed, helpful. However, Microsoft has taken a more-aggressive approach by totally redesigning the keyboard itself.

The keys are split into left- and right-hand pods. The left-hand section contains function keys F1 through F5, numeric keys 1 through 6, top row q-w-e-r-t, middle row a-s-d-f-g and bottom row z-x-c-v-b keys. The right-hand section covers function keys F6 through F12, numeric keys 7-8-9-0-hyphen-= and backspace, top row keys y-u-i-o-p-[-]-\, middle row keys h-j-k-l-;-' and enter, and bottom row n-m-,-.-/ and shift. An inverted-T cursor arrow pad, Insert/Home/Page Up/Delete/End and Page Down pad and a Print Screen/Scroll Lock/Pause keypad are located between the right-hand keypad and the numeric calculator keypad at the far right.

In addition to the usual complement of Tab, Control, Alternate and Shift keys, two additional keys are labeled with the *Windows* logo that, when used with the accompanying IntelliType software application, simplify *Windows* functionality, such as task management and mouse functions.

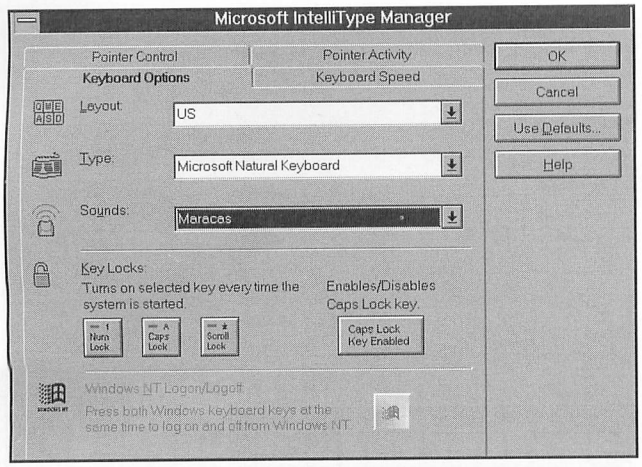
The left-hand keypad slopes to the left, while the right slopes to the right. The keyboard has an extended front apron that functions as a rest for the heels of your palms. After a little bit of getting used to this new positioning scheme, the feel becomes very natural and comfortable. A wrist leveler is also located under the front palm rest and permits adjustment to provide a natural wrist position over a range of desk heights.

Microsoft's Natural Keyboard splits and slopes the keys to naturally position and supports your hands, wrists and forearms. The ergonomic design is a major factor in reducing the risks of contracting Carpal Tunnel Syndrome.

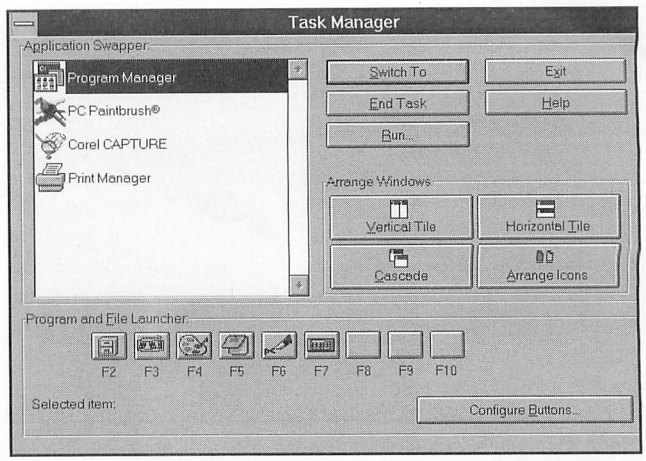
Included with the Natural Keyboard is a diskette that contains two applets: the IntelliType Manager and the graphical Task Manager. Installation of the software is simple and proceeds from within *Windows*. From the IntelliType Manger, you can specify settings and preferences for the way you want to use the Microsoft Natural Keyboard. It should be noted, however, that none of the features of the Pointer Activity and Pointer Control tabs are available unless the keyboard is installed on the system, although you can use some of the other functions (for example, keyboard layout and sound effects) with other keyboards.

The graphical Task Manager applet, another included application, lets you assign programs and files to various function keys and perform such other tasks as arranging your windows by clicking on an action button. Combined with the extra functionality built into the keyboard itself, the software applet is really a time saver for accessing frequently-used programs and operations.

If you're concerned about repetitive-stress injuries, or if you're just looking for a more-comfort



The IntelliType Manager applet permits configuring preferences for the Microsoft Natural Keyboard, such as assigning sounds to keypresses, changing layout, etc. While the software can be used with other keyboard types, only the Natural Keyboard permits access to the Pointer Control and Pointer Activity tabs in the applet.



The Natural Keyboard's graphical Task Manager applet allows you to assign program and file launchers to various function keys, arrange the appearance of your screen and switch between open tasks by clicking on them, among other things.

able, efficient keyboard, check out the Microsoft Natural Keyboard. Sometimes different is better, and this keyboard is both different and better.

Surge Suppressers

Anyone who isn't using a surge protector to guard against the possibility of surges and spikes damaging his computer equipment is playing the electronic equivalent of Russian Roulette. Sooner or later, his equipment going to get hurt, and hurt bad. Not all surge suppressers are created equal, however. As with everything else, there are varying grades of product in the marketplace.

I recently became aware of what has to be the "Rolls Royce" line of surge suppressers from Price Wheeler. Available in different ratings and physical configurations, Price Wheeler's surge suppressers are immune to damage from repeated surges or spikes which, over time, reduce the efficiency of other competitive units. The company's patented inductive/capacitive/resistive circuit effectively limits voltage and current, stores residual energy and slowly dissipates it to the neutral ac line at harmless levels.

With no MOVs or other "sacrificial" components, surge-current or joule-rating limitations, the Price Wheeler products won't fail with time nor experience any degradation in operational effectiveness. Price Wheeler backs its various models with an unprecedented 10-year limited warranty, further attesting to the quality of its products.

The Model PW900 has a 900-watt capacity (7.5 amperes at 120 volts) and is sufficient to support two PCs with dot-matrix printers. It retails for $139 and is available as a stand-alone or hard-wired unit. The Model PW-1800 has an 1,800-watt capacity (15 amperes at 120 volts) and provides adequate protection for two PCs and a laser printer. Like the PW900, the PW-1800 is available in both stand-alone and hard-wired configurations for $159.

Price Wheeler also offers rack-mount units in 15-ampere ($229) and 30-ampere ($429) capacities for those applications in which this type of industrial strength is required.

When you consider the investment you have in your PC, CD-ROM drive, video monitor, external storage devices, printer and other components of your computer system, it doesn't make sense to leave yourself open to the ravages of untamed line current. These Price Wheeler units will give you all the protection you need, and they're made from top-grade components right here in the United States.

Multimedia Software

Since last issue, a number of new software titles for multimedia work on a PC have come my way. Here's a run-down of a few of the more-interesting ones you might want to consider investing in.

• ***EasyKeys* 2.0.** Blue Ribbon Soundworks has just released Version 2.0 of its outstanding *EasyKeys* program. If you're interested in creating some great-sounding music for your multimedia applications or just for fun, this is the easiest way to do it—even if you're totally tone deaf!

The *EasyKeys* program, supplied on a CD-ROM, loads to your hard disk and transforms your PC into an electronic keyboard with features found on keyboard synthesizers costing hundreds of dollars. The power of the program comes from its artificial-intelligence engine that does the work for you by automatically permitting notes that "work" with the chords or other parts being played at that instant.

The program is as easy to use as loading the application and clicking on the start button, at which point, the "LEDs" start to move. Then all your have to do is click your mouse to add an effect or two, jam along with the generated music and get down and funky.

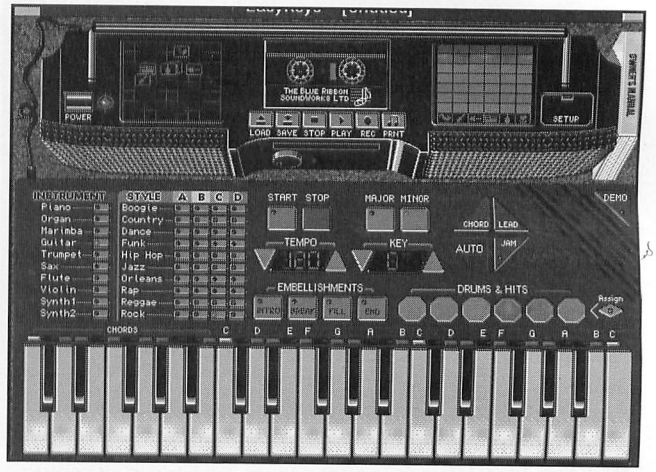
More than 40 different "grooves" are provided to play with, and you can choose from 10 different musical styles, including rock, rap, hip-hop, boogie, country and more. Automatic features like one-touch chord playing and never-miss-a-note soloing can make anyone sound like an accomplished musician, even if he's never played a note in his life.

In addition to the enhanced groove and style palette, you can record and save your musical compositions to play back and/or incorporate into your multimedia presentations. With the included Notation Station capability (a $29.95 value), you can even display and print your created musical score in standard music notation.

You can use either keyboard or mouse to play along. The program comes with dozens of cool .WAV-format sound effects. It also has an auto-configuration feature that sets the software up to work and sound properly with your installed sound card or MIDI instrument.

EasyKeys 2.0 is an amazing example of harnessing the computer's power to produce an application that's fun and fascinating to use. You'll be amazed at just how good you can sound, regardless of your musical talent level.

Price Wheeler's surge suppressers are available in different capacities and physical configurations, including stand-alone, hard-wired for internal mounting and rack-mountable units. The Model PW900 (right) offers adequate protection for two PCs with dot-matrix printers, has six grounded outlets, a convenient on/off switch, a circuit reset button and built-in self tester.



EasyKeys 2.0 is the easiest way to produce music on a PC equipped with a sound card, regardless of your musical talent level, and operates like an actual keyboard synthesizer with a digital recording deck built in. Despite it's fun look, it's capable of producing surprisingly sophisticated musical scores.

• ***Melody Maestro* 2.0.** If you can hum, you can make music with *Melody Maestro* 2.0, the latest upgrade to the original Blue Ribbon Soundworks title that set the multimedia music-making world on its ear—literally!

The program is supplied on two 3½" floppy diskettes, and a good-quality microphone is supplied in the package. So you're ready to load the software, plug the mike into your sound card and start making music right away. Using the program, you can quickly and easily transform a few simple notes into an original piece of music. The software's exclusive cue-card interface guides you every step of the way, from the first note to the final chord. Thus, you don't have to be a schooled musician to create elaborate musical compositions.

In truth, you don't even have to be able to carry a tune to have fun with *Melody Maestro* 2.0. The process of composition consists of choosing a style for the type of music you want to create, such as jazz, rock, classical or New Age. Once you've decided on a style, you're ready to create a melody with the microphone (you can also use a MIDI keyboard or mouse). If you want, *Melody Maestro* will even create the melody for you. Once you're satisfied with the melody (and you can keep generating changes to all or part of it as much as you like), the program will enhance your music in dozens of ways by altering "grooves," changing background passages, putting in "bridges," etc.

Based on your melody, the program writes the musical accompaniment for you, placing drum fills, piano licks and other musical embellishments right where you need them. You can change tempo and key and choose from a variety of instruments to suit your tastes. Because you can also edit your melody on a graphical grid, knowledge of musical notation isn't required, either.

More than 50 musical styles and more than 200 musical "grooves" are provided. You can while away countless hours just playing with different styles, instrument textures and tempos. Changing from one style to another, like every other functional parameter in the program, takes but a click of your mouse.

As with *Easy Keys* 2.0, *Melody Maestro* 2.0 has the ability to print your own compositions in sheet music using the included Notation Station software. And because you can also save your song as a MIDI file, you can play it in dozens of programs or incorporate it into other applications.

If you've ever wanted to make music but lacked the skill or knowledge to play an instrument, *Melody Maestro* is the magical musical bridge that will make it all possible for you.

• ***AudioTracks Professional.*** If you have serious multimedia musical soundtrack needs, you've probably tried several of the "canned" royalty-free MIDI and .WAV file libraries that abound. While these are good, the main problem is that everyone seems to be using them. So there isn't much originality available for your soundtracks anymore.

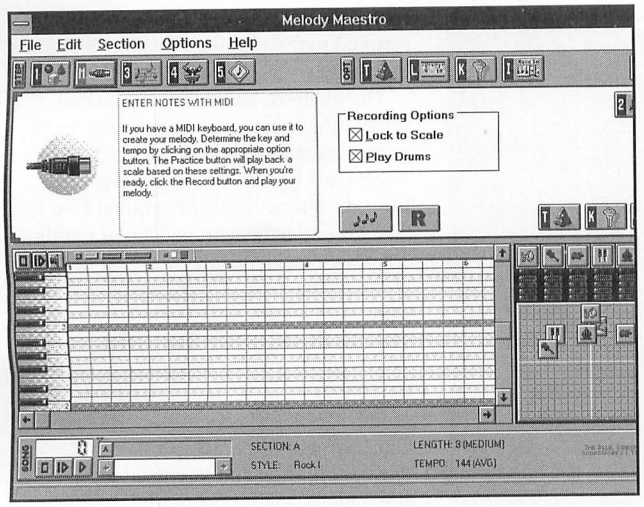
Your alternatives are to commission a multimedia musician to create specifically for your needs or to go ahead and create the score yourself. The former proposition can be costly, often fetching a price tag of several hundreds of dollars for a short segment. For considerably less money, you can get yourself a copy of *AudioTracks Professional* and easily create your own killer soundtracks. The best part about it is that the program creates original music each and every time.

The program creates music in endless moods and personalities, from industrial to romantic, dramatic to humorous, adventurous to lonely and much more. There's also an assortment of customized backup "bands" with varied instrumentation to give your compositions additional color and dimension, which can be further altered using a unique mixing grid to change spatial and volume relationships of the "musicians." For example, you can move the drums higher on the grid to make them louder, move the guitar to the left to have it pan left, move the piano to the right to have it pan right, etc.

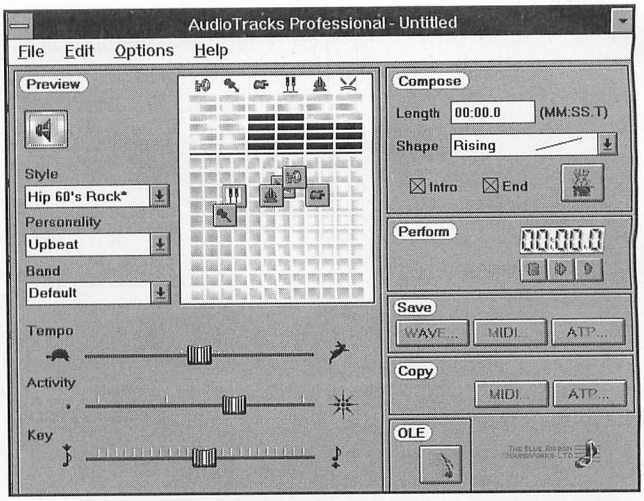
Whether you need a brass fanfare for your next sales pitch or the perfect finale for your latest multimedia show, *AudioTracks*' artificial-intelligence engine will personalize your music down to a tenth-of-a-second resolution. The package is incredibly rich in features and options for creating not just original—amazingly good original—music that rivals and surpasses what you'll find in "canned" libraries.

Even if you don't have serious multimedia musical scores, you'll find the package to be lots of fun to work with, and it will give you hours and hours of enjoyment. The big plus is that every time you launch it, the music that results will be totally original and something you haven't heard before.

• ***Mission Code: Millennium.*** Working with computers on a daily basis, it's easy to become jaded and forget what life was like before these silicon wonders became standard parts of our desktops. But every now and then, I happen across a program that reminds me how PCs have changed our



Melody Maestro supplies the software and microphone; you supply the sound card, hum into the mike and—*voilá*—a song is born. Making multimedia music, even for the totally inept, doesn't get easier than this!



AudioTracks Professional creates original music every time, eliminates the hassles of copyright fees and royalties, contains more than 50 musical styles with more than 200 musical grooves and exports the created music to either MIDI or .WAV file formats.

lives and how today's kids have all the advantages of multimedia to aid them in learning. The paradox is that I'm sure they don't have the foggiest idea how lucky they are.

Mission Code: Millennium is one of these new applications that really uses multimedia well to create a most effective learning tool. It offers kids (ages eight to adult) an exciting way to explore important developments in history, literature and the arts over the past thousand years. Relying heavily on a 3D rendered "futuristic" graphic look and feel, complete with a team of animated robots and live actors, these trappings add an engaging realism and play value to the educational experience contained on this CD-ROM. It's been hailed as being "like *Carmen Sandiego* meets *Quantum Leap*," which is a fairly accurate description.

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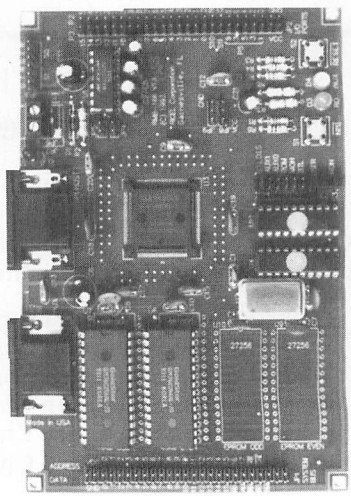

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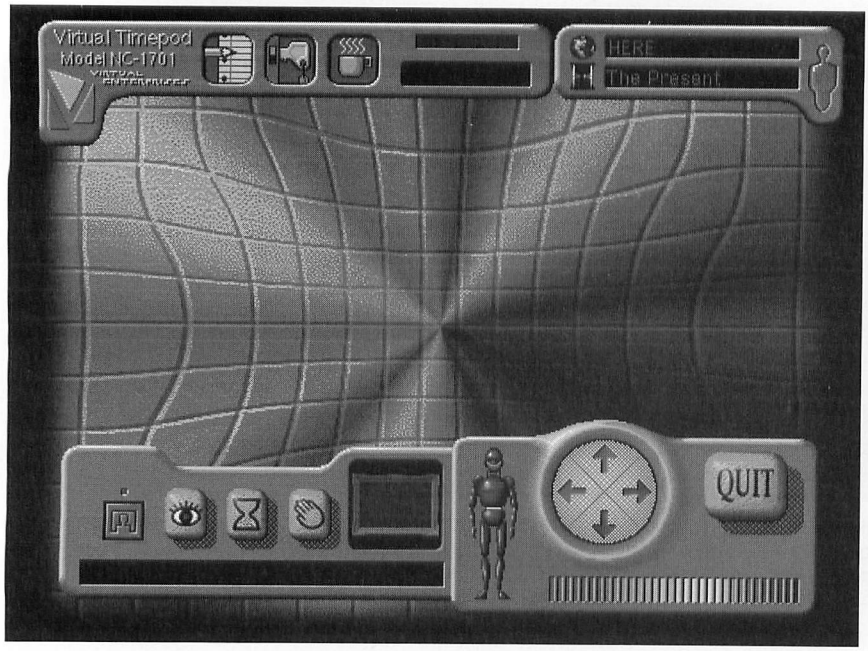

In *Mission Code: Millennium* you warp through the fabric of time to recover stolen objects and return them to their proper chronological place in history. A team of 3D animated robots assists you in your quest. The production values of this educational adventure game will keep every member of the family enthralled for hours on end.

The program puts the player in the role of a "virtual time traveler" who is assigned to solve 16 different missions in a quest to replace authentic stolen objects (more than 100 total). These objects include blueprints for the Tower of Pisa, works of William Shakespeare, paintings by Rembrandt and other such timeless treasures. These pilfered objects have to be recovered and restored to their proper chronological place in history.

The 3D look, animation, music and sound effects are what we've come to expect in recreational products like *Dark Forces* and the *7th Guest*, but this is the first educational software product I've seen that's right on the cutting edge of multimedia design and holds its own with the best of the recreational offerings. Some of the features that make it a standout title are multiple digital movies of live actors, fully animated 3D worlds, motion-picture quality soundtrack, crisp CD-quality speech and sound effects and a multi-player database for classroom or family use.

Both children and young adults (mom and dad, too) will experience countless hours of learning enjoyment exploring historical treasures in art, literature, science, music and architecture with a team of animated robots in a high-stakes adventure game. The production values are top-drawer throughout, and the content is both entertaining and educational at the same time. If you're looking for a multimedia CD-ROM the whole family can enjoy, checkout *Mission Code: Millennium.*■

Products Mentioned

Microsoft Natural Keyboard, $99.95
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
Tel.: 206-882-8080

CIRCLE NO.156 ON FREE INFORMATION CARD

Price Wheeler Surge Suppressers, $139 to $429
Price Wheeler Corp.
2329 State Hwy. 34
Manasquan, NJ 08736
Tel.: 800-528-0313

CIRCLE NO. 157 ON FREE INFORMATION CARD

EasyKeys 2.0, about $39.95; *Melody Maestro* 2.0, about $49.95; *AudioTracks Professional*, about $149.95
The Blue Ribbon Soundworks Ltd.
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Industry Watch By John Hastings

The AmCoEx Index of Used Computer Prices

By any measurement, Apple Computer's new Power Macintosh sales have been a tremendous success, exceeding Apple's own optimistic first-year estimates by more than 25%. Now, the company is predicting up to 200% compound annual growth in sales for the next few years.

One of the things that will fuel Apple's sales growth is a new type of expansion bus for the computers that's due out this summer. The old proprietary NuBus slots will be replaced by industry-standard PCI slots. This will permit Macintosh users to avail themselves of many of the same expansion cards now available for IBM/compatible computers.

In preliminary tests, most of the cards have performed substantially faster on the Power Macs than on comparably equipped Pentium-based computers. Most video cards, for example, performed up to 250% faster on the Power Macs. This is an important piece of the puzzle in Apple's strategy for future growth.

While *Windows* technology mimics the Macintosh in many ways, the Macintosh has an almost insurmountable lead in full-motion video. Apple is investing significant resources in expanding this lead. It's currently demonstrating new software for virtual-reality and three-dimensional software development. These new development tools and faster hardware will permit programmers to develop more- realistic games and educational software. But, this is only the beginning. Apple will utilize this technology to establish a lead position in interactive television and video teleconferencing.

Many of the problems in the *Windows* operating system stem from the fact that an early design criteria stated that *Windows* must be able to run on 286 computers. This requirement made sense in 1989, when most computers were 286-based. But today, this legacy has prevented the platform from realizing its potential.

Much of the delay in OS/2 and *Windows 95* has been due to the requirement that the operating systems function in computers with only 4M of RAM. Again, this requirement made sense when it was first proposed, but minimum hardware configurations are increasing every day. The Apple Power Macintosh doesn't run new software as fast as possible because backward-compatibility and emulation for old software limits the speed of the new software.

Fortunately, developers are beginning to realize that operating systems should be developed for future hardware, not present or past configurations. The predicted short life of *Windows 95* will certainly bring this lesson home to Microsoft. Since *Windows 95* will likely be obsolete when the P7 CPU is introduced in 1997, it's doubtful if Microsoft will completely recoup its investment in this product. At that time, however, Microsoft will finally take mainstream computing to *Windows NT*, a product designed for future computers.

Apple also seems to have learned its lesson. Future Macintosh operating systems will probably work on only Power Macs. While leaving the older machines behind, the new systems can be as powerful as possible.

Prices For Used Computer Equipment as of June 28

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change($)
IBM PS/2 Model 70, 60M	$350	$600	$325	–50
IBM PS/1 486DX2/50, 253M	800	1,350	850	–50
IBM PS/2 Model 90, 160M	900	1,300	925	–75
IBM ThinkPad 350C	1,600	1,950	1,625	–125
IBM ThinkPad 700	900	1,500	1,000	—
IBM ThinkPad 720	1,100	1,800	1,250	–100
AST 486SX/25, 170M	650	1,050	650	–50
AST 486DX/66, 340M	850	1,400	800	125
Dell 386/33, 100M	450	850	475	—
Dell 486DX/33, 240M	700	1,150	700	–125
Gateway 386/25, 80M	350	700	425	+25
Gateway 486/33, 120M	700	1,100	750	–150
Clone Notebook 386SX, 40M	400	900	475	+25
Clone 386/33, 80M, VGA	350	700	400	—
Clone 486/25, 120M, VGA	700	1,200	725	–125
Clone 486DX/33, 240M	800	1,425	775	–125
Compaq LTE 286 40M	250	675	300	–25
Compaq Contura, 320 60M	500	1,000	600	–50
Compaq Contura 4/25 120M	900	1,400	800	–125
Compaq Deskpro 386/20e, 100M	400	800	400	–25
Compaq Deskpro 486/33 120M	750	1,300	825	–25
Mac Classic II, 80M	350	800	425	—
Mac IIsi 160M	500	900	475	–125
Macintosh IIcx, 80M	250	600	300	—
Macintosh IIci, 80M	500	950	550	–75
Macintosh IIfx, 80M	600	1,000	675	–50
Mac Quadra 700, 230M	1,000	1,600	950	–175
Mac Quadra 800, 500M	1,600	2,300	1,600	–125
PowerBook 140, 40M	700	1,100	725	–100
PowerBook 170, 40M	800	1,350	900	–25
PowerBook 180, 80M	1,200	1,850	1,550	+50
LaserWriterPro 630	1,100	1,650	1,250	–50
Toshiba 1900 120M	675	1,150	675	–50
Toshiba 3200 SXC, 120M	1,850	2,950	1,900	–100
Toshiba 3300SL 120M	850	1,300	825	–100
Toshiba 5200, 100M	750	1,050	775	–25
HP LaserJet II	350	850	425	–25
HP LaserJet IIIP	250	650	375	+25
HP LaserJet III	500	900	600	–25
HP LaserJet IV	800	1,200	950	+25

It's most likely that your dream computer today would cost approximately $5,000. It's equally likely that your dream computer five years ago, though radically different in power and configuration, also would have cost $5,000. Most state-of-the-art desktop and notebook computers are priced in the $5,000 range. This has nothing to do with cost and everything to do with supply and demand.

In a new-generation computer, CPU chips are in limited supply, but demand will likely match that supply at the $5,000 price point. Beyond this point, demand all but vanishes. Within months of its introduction, supply of new CPU chips increases and manufacturers need to reach a larger market. Hence, prices begin to fall. Approximately 12 to 18 months after introduction of a new model, computer manufacturers need to reach a broad market. Anything less than $2,000 will reach this market. While this pattern began more than 10 years ago, there appears to be no end in sight.

New color notebook computers will be getting larger screens soon. While most color screens measure 8" to 9" diagonally, the largest screens available today are 10.4". These will soon be replaced by 11.3" screens that offer almost 20% more viewing area. Some will even give decent Super-VGA performance. One company may offer a 12.1" screen later this year. These new notebooks are expected to cost approximately $5,000.

Intel is beginning to feel the heat of competition as it never has before. In the past, the life cycle of each generation of CPU chip was measured in years. This permitted Intel to recoup its investment and continue to manufacture extremely profitable chips. As competition encroached, Intel would introduce the next generation of CPU chips, allowing its competitors the crumbs that were left.

Today, new generations of CPU chips are measured in months. This shortens the most-profitable period of chip production. IBM and Motorola are producing in quantity new versions of the PowerPC CPU chips that dramatically surpass Intel's best performers. This is forcing Intel to bring out new generations of chips much sooner than it otherwise would. For example, the 133-MHz PowerPC 604 chip from IBM performs 25% faster than the just announced 133-MHz Pentium chip from Intel. With a price that's 20% less than the Pentium chip, the PowerPC chip has put Intel in a double pincer.

Intel must now scurry to introduce the next generation P6 CPU, due by the end of this year. Since the P6 will only equal the performance of the current PowerPC, there will be very little room for pricing premiums for the chip. The net effect of this competition will be much-faster, less-expensive new computers. Technological changes are going to come faster than ever.

Used Computer Equipment Priced as of July 25

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change($)
IBM PS/2 Model 70, 60M	$250	$500	$300	–25
IBM PS/1 486DX2/50 ,253M	700	1,150	825	–25
IBM PS/2 Model 90, 160M	725	1,100	825	–100
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IBM ThinkPad 700	900	1,500	950	–50
IBM ThinkPad 720	1,100	1,800	1,175	–75
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AST 486DX/66, 340M	600	1,000	800	—
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Gateway 486/33, 120M	600	900	650	–100
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Mac Classic, II 80M	350	800	400	–25
Mac IIsi, 160M	300	750	425	–50
Macintosh IIcx, 80M	250	600	275	–25
Macintosh IIci, 80M	400	850	500	–50
Macintosh IIfx, 80M	500	1,000	575	–100
Mac Quadra 700, 230M	800	1,400	925	–25
Mac Quadra 800, 500M	900	1,500	1,400	–200
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Toshiba 5200, 100M	750	1,050	775	–25
HP LaserJet II	350	850	425	—
HP LaserJet IIIP	250	650	350	–25
HP LaserJet III	500	900	575	–25
HP LaserJet IV	800	1,200	975	+25

More News

"Just say no" to new operating systems. This is the advice given by many experts in the computer industry. The second version is always cleaner than the first. Today's computer operating systems are incredibly complex. To expect the first version to work well is naive.

When *Windows* 3.0 was introduced, most people found it to be almost unusable. Version 3.1 solved most of the large problems. When Apple's System 7 was first released, the problems ranged from irritating to catastrophic. System 7.1 smoothed the situation. System 7.5 introduced many new features and new bugs. System 7.5.1 resolved the bugs.

Apple has always planned to offer its System 8 in a form that will run on any PowerPC computer. This will include new computers from IBM, Canon and possibly Zenith. Because of the new operating-system stigma, however, Apple is considering modifying its System 7.5 to run on these new machines.

Many corporate users may be more willing to quickly adopt a tried-and-true version more. Because it's almost a year and a half late, many skeptics think Microsoft is rushing *Windows 95* to market with numerous problems unresolved. Their advice is to wait for *Windows 95* Version 1.1, pointing out that "those who do not study history are destined to repeat it."

Apple Computer has stepped up to the plate and hit a home run. Its newest version of the Power Macintosh is almost twice as fast as its previous versions. In addition, the new computer is also twice as fast as the newest 133-MHz Pentium computers. The Power Macintosh 9500 is based on a new generation of PowerPC CPU chip. The new PowerPC 604 was redesigned from the ground up. The original PowerPC 601 was hurriedly thrown together. Its purpose was more of a viability study than a technological breakthrough.

Having proved its viability, IBM and Motorola redesigned the PowerPC 604 chip to maximize performance. The current speedster runs at 132 MHz, but some industry analysts say the 150-MHz and

180-MHz versions will be out later this year or early next year. Apple put this technology to good use with improved operating-system software. By maximizing the benefits of the new processor, the new software enables the new Mac to exceed most critics' expectations. Additional operating-system improvements permit older software applications be run much faster on the new machines.

While the current offering is the high-end machine in Apple's product line, less-expensive models are expected to appear by the time you read this. These new offerings are expected to be priced aggressively. This introduction could cause prices of older Macs, especially the Quadras, to tumble.

IBM has announced it will license the Macintosh operating system, likely installing the software on computers it will produce next year. Some people expect other manufacturers, like Canon and Zenith, to follow suit.

Microsoft and Apple have developed graphic tools that will enable software designers to make better use of their operating systems. The three-dimensional and virtual-reality tools are primarily for software companies that develop games. This strategy will enable the computer giants to compete with Nintendo and Sega. Since more money was spent in the past year on computer games than movie admissions and rentals, this seems to be a market worth the effort.

As a trump card, the computer companies will have the ability to permit game players to compete with each other over the Internet. Teams and leagues are expected to form around the world.

Congress is currently contemplating the Communications Decency Act, legislation designed to clean up the smut available on the Internet. Offenders will be subject to a $100,000 fine and two years imprisonment—that is, if offenders are in the United States. What Congress seems to ignore is the world-wide perasive-ness of the Internet. On the World Wide Web, users can easily and instantly connect to systems in England, Sweden, Australia or any other country. Unless our Congress can convince all other countries to adopt similar legislation, its efforts will be little more than ceremonial. The real solution, some experts say, is self-regulation. Several companies are forming a coalition to permit parents to control material their children can access. Like movies, Internet sites would be rated. ■

Since 1988, the American Computer Exchange has matched buyers and sellers of used microcomputer equipment. For more information contact the American Computer Exchange at 800-786-0717 or http://www.crl.com/~amcoex.

Bits 'n' Pieces *(Continued from page 91)*

Programs menus, create shortcuts to frequently used files and display them as Desktop icons, set your computer's date and time, customize your *Windows 95* display to suit your preferences and configure your mouse to reflect the way you work.

Beginning with Part 2, you're on your way to doing useful work with your PC under *Windows 95*. Lesson 4 introduces you to *Windows 95*'s built-in WordPad text editor for creating, editing, formatting and viewing short text documents. In Lesson 5 you're given a basic introduction to drawing pictures with the Paint program included in *Win95*. Lessons 6 and 7 guide you through using *Windows*- and DOS-based programs, respectively.

With Part 3, you learn how to store and organize your work. For example, Lesson 8 shows you how to set up a filing system. Next, Lesson 9 has you managing files and disks. Then, in Lesson 10, you're stepped through the procedure for locating your files.

Part 4, titled Communicating Your Work, consists of two lessons. Lesson 11 details how you can share your information between computers, while Lesson 12 steps you through connecting computers through telephone lines.

An appendix provides instructions for installing *Windows 95* on your PC if you haven't already done so. This appendix simply parrots the installation instructions provided in the brief manual that comes with *Windows 95*. It's followed by a glossary.

The foregoing might give you some idea of what's in this book/diskette combo, but it doesn't begin to tell you how well-thought-out and enjoyable the experience can be actually using it. The lessons are designed to be completed consecutively, of course, and each lesson is rated to take a minimum of your time, the longest at 40 minutes and the shortest at 20 minutes. The text is brief and to the point. Each step to be performed is by the numbers. Liberal use of screen captures throughout the lessons keeps you on-target all the way. If you don't see on your screen what's shown in the book, you did something wrong.

No program of this nature would be very effective if it doesn't give immediate feedback. This one does. You read the lesson, initiate the actions and see the result immediately. Each Part concludes with a Review & Practice section, through which you gauge your progress. With everything this book/diskette combo has going for it, I'd opt for this method over a video that covers the same ground. Having skimmed through most of the lessons and performed selected portions, I'm more than satisfied with the results.

Both the *Field Guide to Microsoft Windows 95* and *Microsoft Windows 95 Step By Step* belong in the libraries of anyone who has moved up to this newest of operating systems. And if you know someone who has recently moved up to Windows 95 and are looking for a worthwhile holiday gift for him or her, either or both titles will be welcomed.

Internet Resource

The Waite Group has done it again with a superb new title for Internet devotees. The *HTML Web Publisher's Construction Kit* is a book/CD-ROM combo (soft cover, 673 pages, $36.95) by David Fox and Troy Browning you won't want to miss if you want to become a canny user of the Internet. This book covers everything you need to know for connecting to and exploring the Web, authoring your own Web pages with HTML tools and setting up your own Web site. The included CD-ROM contains a set of popular Web-browsing tools, including *Lynx*, *SlipKnot*, *NewManage* and *Chameleon*; premium Web publishing software for *Windows*; and all the software you need for setting up a Web site. It serves as a tour guide to the best Web pages around. And for novices, it even includes an Internet account.

The *Kit* offers step-by-step instructions at each level: from the procedures for installing converters, transfer protocols and communication sockets needed for Web browsing to the nuances of constructing a document with graphics, hypertext, movie and animation. Each chapter in this section opens with an actual Web document that's then dissected to illustrate precisely how each aspect was created. Sample documents are analyzed not only in terms of their attendant technology, but for style, esthetics and rhetorical appeal as well.

This book assumes you're vaguely familiar with the on-line world, the Internet and Microsoft *Windows*. Other than that, chapters in this book each have a number of lessons. Easy concepts are covered first, more difficult and obscure things come later. Once you've satisfied the basic requirements, you're ready to jump in with both feet.

Right up front, the *HTML Publisher's Construction Kit* introduces the *Chameleon* sampler on the CD-ROM. After telling you what Internet tools are available

(Continued on page 109)

Located at $103F.

7	6	5	4	3	2	1	0
EE3	EE2	EE1	EE0	0	NOCOP	0	EEON

EE0-EE3–EEPROM Map Position
These four bits specify the upper four bits of the EEPROM address. These bits have no meaning in single-chip mode, because the 2K EEPROM is forced on at locations $F800 through $FFFF.

EE3	EE2	EE1	EE0	Location
0	0	0	0	$0800-$0FFF
0	0	0	1	$1800-$1FFF
0	0	1	0	$2800-$2FFF
0	0	1	1	$3800-$3FFF
0	1	0	0	$4800-$4FFF
0	1	0	1	$5800-$5FFF
0	1	1	0	$6800-$6FFF
0	1	1	1	$7800-$7FFF
1	0	0	0	$8800-$8FFF
1	0	0	1	$9800-$9FFF
1	0	1	0	$A800-$AFFF
1	0	1	1	$B800-$BFFF
1	1	0	0	$C800-$CFFF
1	1	0	1	$D800-$DFFF
1	1	1	0	$E800-$EFFF
1	1	1	1	$F800-$FFFF

Bit 3 Not implemented.

NOCOP 1 COP watchdog system disabled

0 COP watchdog system enabled

Bit 1 Not implemented

EEON 1 On chip EEPROM enabled

0 EEPROM disabled (memory space becomes externally accessed space.)

Note: The above table only pertains to the 2K EEPROM (HC811) version. It is not possible to change the EEPROM Map position of the HC11–its 512 bytes are permanently located between $B600 and $B7FF.

Fig. 4. System Configuration Register for the MC68HC811E2.

you can purchase a ready-to-wire one from the source given in the Note at the end of the Parts List.

Once your board is ready, refer to Fig. 3 and start wiring it by installing and soldering into place the IC sockets. Proceed to the resistors, capacitors, diodes, LEDs, crystal, potentiometers, switch and jumper blocks. Make certain that the diodes, LEDs, resistor networks and electrolytic capacitors are properly oriented before soldering any of their pins into place.

Be sure to remove pin 2 from *J1*. This is done for polarizing (insurance) purposes. Obviously, a socket is necessary at location *U1*. Also, it's wise to have a socket at *U3* to increase the versatility of MAGPRO-11. IC Sockets at the other locations are optional. Installation of *U8*, *D1*, *LED3*, *LED4* and associated resistors is optional. Do *not* the plug ICs into their sockets until after you've completed initial voltage tests.

Double-check your work to make certain that each component is in its proper location and is properly positioned. Examine each soldered connection. Clear any solder bridges you might have created between closely-spaced pads and traces. Solder any connections you may have missed, and reflow the solder on any connection that appears to be suspicious.

When you do plug the ICs into their various sockets, make sure each is properly oriented. Also, make sure all pins properly engage the sockets so that none overhang the sockets or fold under between ICs and sockets.

Initial Tests

You can power MAGPRO-11 from a variety of dc sources ranging from a regulated 5 volts to an unregulated 13 volts. Because of its low current requirements (about 50 mA), it can even be powered for a short period of time by a 9-volt battery.

While it's possible to wire power-supply leads directly to the board, I recommended that you make use of a four-circuit connector. Notice in Fig. 1 that only pins 3 and 4 are used if a regulated 5-volt source is used. Pins 1 and 4 are used if an unregulated but filtered dc supply of from 8 to 13 volts is used. For both supplies, pin 4 is ground. Also, for safety sake, polar-

```
>?

ASM [<addr>]  Line asm/disasm
  [/,=]  Same addr,        [^,-]  Prev addr,        [+,CTLJ]
Next addr
  [CR]  Next opcode,                                [CTLA,.]
Quit
BF <addr1> <addr2> [<data>]  Block fill memory
BR [-][<addr>] Set up bkpt table
BULK  Erase EEPROM,                  BULKALL  Erase EEPROM
and CONFIG
CALL [<addr>] Call subroutine
GO [<addr>] Execute code at addr,         PROCEED  Continue
execution
EEMOD [<addr> [<addr>]] Modify EEPROM range
LOAD, VERIFY [T] <host dwnld command>  Load or verify S-
records
MD [<addr1> [<addr2>]]  Memory dump
MM [<addr>] or [<addr>]/  Memory Modify
  [/,=]  Same addr,  [^,-,CTLH] Prev addr,  [+,CTLJ,SPACE]
Next addr
  <addr>O Compute offset,                         [CR]  Quit
MOVE <s1> <s2> [<d>]  Block move
OFFSET [-]<arg>  Offset for download
RM [P,Y,X,A,B,C,S]  Register modify
STOPAT <addr>  Trace until addr
T [<n>]  Trace n instructions
TM  Transparent mode (CTLA = exit, CTLB = send brk)
[CTLW]  Wait,          [CTLX,DEL] Abort          [CR] Repeat
last cmd

_>
```

Fig. 5. BUFFALO Monitor's Help Screen.

ize the plug by inserting a polarizing plug in hole 2. If you use an unregulated supply, be sure to place a jumper at *JP3*. Failure to do so won't hurt anything, but nothing will work!

When you apply power with no ICs in the sockets, green *LED2* should light. Connect the negative lead of a dc voltmeter or multimeter set to the dc-volts function to circuit ground. Using the positive lead of the meter, check the +5-volt pin on all IC sockets. For instance, make sure pin 26 of socket *U1* measures between 4.65 and 5.5 volts.

When all voltages check out, disconnect power from the board. Plug the LM324 into the *U8* socket, assuming you're using this chip, and the MAX709L into the *U6* socket. Reapply power to the board and note if *LED3* remains off and yellow *LED4* lights briefly immediately upon power-up. If *LED4* stays lit, the potential is below 4.65 volts and the HCx11 won't function properly. In this event, check out your power supply. Carefully adjust *R16* so that *LED3* just lights and then back off on the adjustment until *LED3* just extinguishes.

If everything appears correct, turn off power and install all remaining ICs. Remember to install a 27C256 EPROM programmed with the BUFFALO monitor firmware. To test MAGPRO-11, you must also install an MC68HC11A1FN or MC68HC811E2FN in the *U1* socket. Use a cable to connect nine-pin serial interface connector *J2* to the serial interface of a computer that's running a suitable communication program. Notice that pin 3 of *J2* is an output, pin 2 is an input and pin 5 is ground. Make sure that the communication program is set for 4,800 baud, eight data bits, two stop bits and full-duplex operation.

Make sure the jumper blocks are set as follows:

JP1—No jumper.

JP2—No jumper.

JP3—Depends on power supply. No jump if 5 volts dc is used.

JP4—Jumper pins 2 and 3.

After setting up the communication program, power up MAGPRO-11. Your PC's video screen should display BUFFALO 3.4 (ext) - Bit User Fast Friendly Aid to Logical Operation. If it doesn't, press the RESET switch on MAGPRO-11. If you still have no luck, connect a logic probe an oscilloscope to pin 11 of *U7*. Press the RESET switch again. If MAGPRO-11 is operating properly, you should detect pulses for a fraction of a second at pin 11 every time you press RESET. If you do detect pulses here, your problem most likely has to do with either your communication program or interface cable.

If you detect no pulses, there's a problem with your MAGPRO-11 board. Most likely, it's a soldered connection if you used a home-made double-sided board with plated-through holes or a misplaced jumper if you used a single-sided board.

Programming HC11s

Since it's a bit simpler to program an HC11 (MC68HC11A1FN) that has a 512-byte EEPROM, than an HC811 (MC68HC811E2FN) that has 2K of EEPROM, I'll first give you a look at programming HC11s. The first step

Note: this memory map is accurate when only U1 is an MC68HC11A1FN. Things are more complicated when an MC68HC811E2FN is used due to its user-selectable EEPROM memory map. Also refer to Fig. 5.

$0000 $00FF	***** 256 BYTE INTERNAL RAM *****
$0100 $0FFF	***** USED BY 6264 RAM (U5) *****
$1000 $103F	****** USED BY INTERNAL REGISTERS **********
$1040 $1FFF	******* USED BY 6264 RAM (U5) *****
$2000 $3FFF	****** PREFERRED ADDRESS RANGE FOR U5 *******
$4000 $7FFF	****** NOT USED **********
$8000 $B5FF	***** NOT USED; ALTHOUGH ADDRESSES SELECTS U2 ******
$B600 $B7FF	****** USED BY HC11'S INTERNAL EEPROM *****
$B800 $DFFF	****** NOT USED; ALTHOUGH ADDRESSES SELECTS U2 *****
$E000 $FFFF	****** BUFFALO MONITOR *******

Fig. 6. MAGPROII memory map.

Fig. 6. MAGPRO11 memory map.

here is to plug the MCU into the *U1* socket. (Be sure to power down whenever plugging an IC into or removing it from its its socket. Also, exercise standard precautions when handling static-sensitive devices.) While it's simple to push this chip into place in the socket, removal is a bit more difficult. Though expensive, single-purpose tools for removing these ICs from their sockets are available, you can ease the chip out of its socket with the blade of a tiny screwdriver. Just be careful and proceed gently and at a snail's pace.

The code/data with which you want to program the EEPROM must be 512 bytes or less in length, assuming you're programming an HC11 and not an HC811. Also, the file must be in standard Motorola .S19 format and should start at B600H. For most cross-assemblers, such as the AS11-NEW provided free by Motorola Freeware BBS, this is no problem.

Connect MAGPRO-11 to the serial interface of your computer and power it up. When you see the BUFFALO prompt, you can start. It isn't possible with BUFFALO Version 3.4 to download an .S19 file directly into EEPROM because of the manner in which an EEPROM is programmed. You want to download the file into external RAM, located between 2000H and 3FFFH, and then use BUFFALO's MOVE command to move the data from RAM into EEPROM.

Since your file starts at B600H and you want to download it starting at 2000H, you use the OFFSET command by simply entering (after typing each entry, hit Enter for the instruction to "take"):

```
OFFSET -9600
```

Don't add an H suffix or a $ prefix since BUFFALO understands only hexadecimal.

Next, enter:

```
LOAD T
```

and then start downloading the .S19 file. After a successful download, "done" will be displayed on your video monitor's screen. When this occurs, enter:

```
MOVE 2000 21FF B600
```

and data will move from addresses 2000 through 21FF to B600 through B7FF. This procedure takes a bit longer because the EEPROM is being programmed.

When it comes to the HC811, it appears that Motorola isn't sure what it's doing. For instance, in Revision 3 of the HC11's 1"-thick Reference Manual, a note concerning the all-important CONFIG register (see Fig. 4) states that this register is shipped programmed with FFH (all bits set), but a change was being considered that would make this value 0FH! HC811s produced in 1993 that I purchased still contain FFH.

What's the big deal? Well, the four most-significant bits of the CONFIG register determine the memory location of the 2K EEPROM. With all 1s in the four most-significant bits (FxH), the EEPROM is located between F800H and FFFFH. The problem here is that this memory location conflicts with the BUFFALO monitor in MAGPRO-11 (located between E000H and FFFFH.). In other words, this presents a problem, though an easily-solved one. If the indicated change was made to ship the CONFIG register with 0FH, the EEPROM would be located between 0800H and 0FFFH. This would permit direct use of the BUFFALO monitor. Also refer to Fig. 5.

It's obvious that you can't use the HC811 exactly as it comes from the factory—or can you? The answer is no and yes. The trick here is to install a jumper at *JP2* so that special test mode is selected after reset. With this mode, the 2K EEPROM is removed from the memory map (see Fig. 6), effectively removing the conflict.

When in test mode, bear in mind that the all-important interrupt and reset vectors are located at BFC0H through BFFFH instead of FFC0H through FFFFH, as with normal expanded mode. This is no problem with MAGPRO-11, which was deliberately designed with redundant-address decoding so that the 27C256 EPROM responds to both ranges of memory addresses.

After installing the jumper at *JP2*, reset MAGPRO-11. Make sure the

.S19 file starts at F800H and includes the appropriate reset vector at locations FFFEH and FFFFH. Also, make sure the file ends at FFFFH. This done, type the following:

```
OFFSET -D800

LOAD T
```

and then download the .S19 file.

The following line sets the EEPROM address range from F800H to FFFFH:

```
EEMOD F800
```

Now use BUFFALO's Memory Modify command to change the CONFIG register located at 103FH from FE to FF by first typing:

```
MM 103F
```

and then

```
FF
```

Finally, use the Move command to program the EEPROM:

```
MOVE 2000 27FF  F800
```

and wait a minute or so for the programming to be completed.

When programming is completed, BUFFALO's prompt (>) appears. Before removing the MCU from its socket, remove the jumper at *JP2* and then reset MAGPRO-11. After programming is completed, the EEPROM resides in locations F800H through FFFFH. Thus, it can be used easily in normal single-chip mode.

Development/ Educational Tool

Since MAGPRO-11 uses the BUFFALO monitor, you can learn a lot about the HC11. BUFFALO can perform a number of tasks for you. Fig. 6 is a screen dump of BUFFALO's help screen, obtained by typing a ? after the > BUFFALO prompt. Some of BUFFALO's commands, such as MM (Memory Modify), LOAD T, OFFSET, EEMOD and MOVE, have been used already. I'll briefly examine one other extremely useful command, ASM, the line assembler/disassembler.

To see how to use BUFFALO's line assembler and demonstrate the tutorial capabilities of MAGPRO-11, let's write a simple program that turns on *LED1* for a second and then off for 2 seconds and continuously repeats itself. The simple program in Listing 1 does just this.

Starting with the BUFFALO prompt, type the data shown in standard bold type. Don't add the $ prefix to indicate a hex number since BUFFALO's line assembler works with only hexadecimal numbers. Make sure you hit Enter when you're done typing the command. The address on the left, shown in italics, is for informational purposes only and shouldn't be entered. The > sign is the BUFFALO prompt.

Line ASM B600 informs BUFFALO that you want to use the line assembler and start at hex address B600. Line LDS #FF loads the stack pointer with hex address FF. This line of code isn't necessary here if this program is being run within BUFFALO, but it's still good practice to include it.

Next, to assure that *LED1* is off, set Bit 4 of Port A, which is accomplished with the next two lines of code. Then to obtain a 1-second delay, jump to the delay subroutine that starts at B614. After returning from the delay subroutine, turn on *LED1* by clearing Bit 4 of Port A with the CLRA (clear accumulator A) and STAA 1000 (store accumulator A at hex address 1000, which is Port A) instructions. Again, jump to the delay subroutine and then branch back to B603 and start over again.

To try out this program, simply type the following:

```
GO B600
```

It should be obvious that, in addition to functioning as an EEPROM programmer for the HC11 and HC-811, MAGPRO-11 can be used as an inexpensive learning tool. Just about all the HC11's software capabilities can be experimented with. Nonetheless, MAGPRO-11's contact with the outside world is limited to a single LED and an asynchronous serial interface. If you'd like a more-versatile development/learning system check, out one of the other systems mentioned earlier.

Coming Soon

Next time, I'll describe the theory, construction and use of MAGTROLL-11 simple single-chip HCx11 controller board whose only firmware is contained in its internal EEPROM. Either an HC11 with 512 bytes of EEPROM or an HC811 with 2K bytes of EEPROM can be used. In later installments, I'll demonstrate a unique practical use for both MAGPRO-11 and MAGTROLL-11. ■

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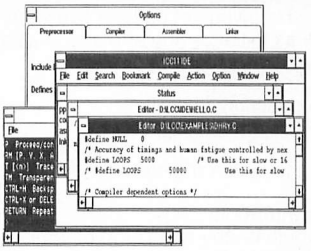
68HC11 ANSI C Development Environment



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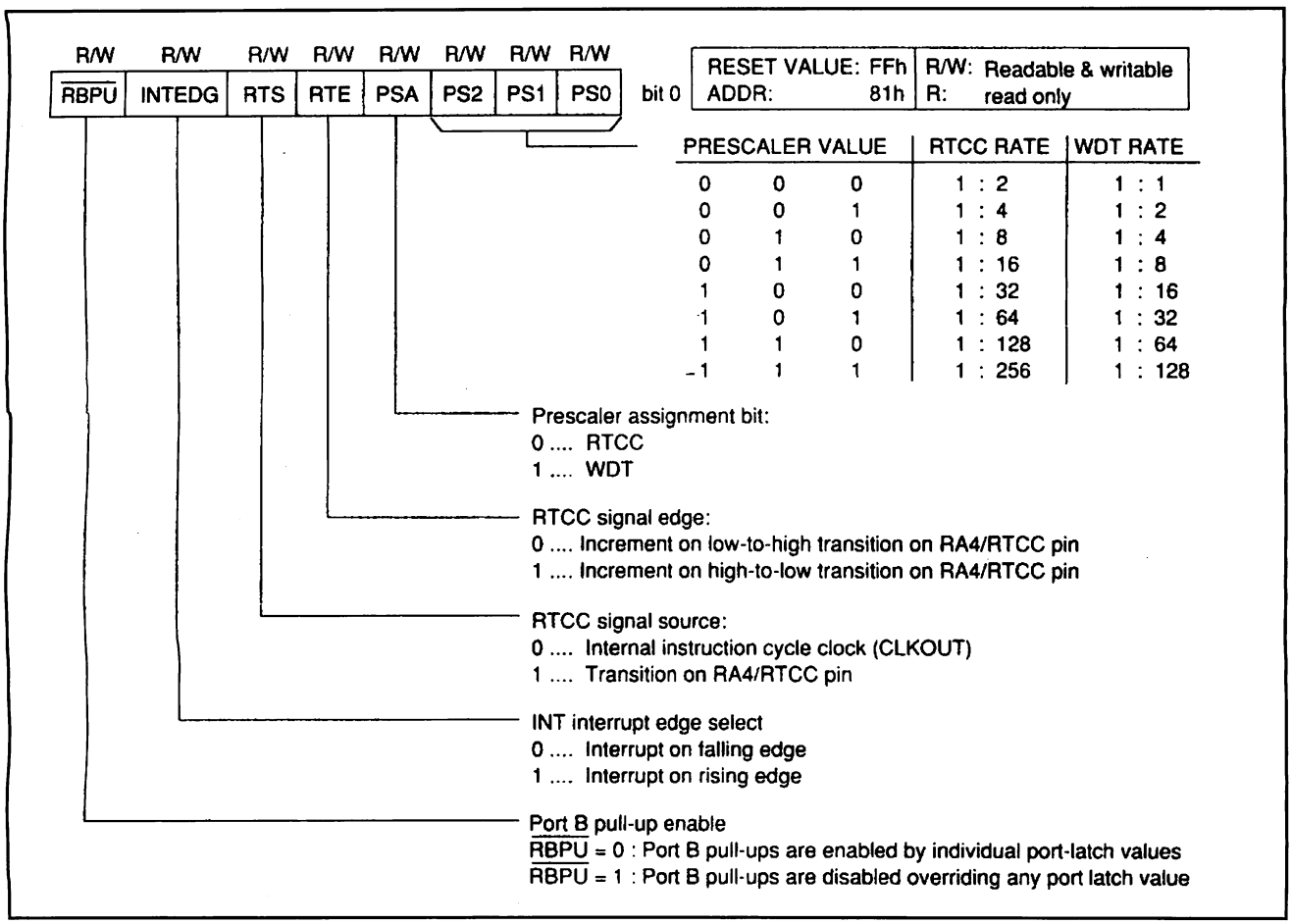
Interrupt Processing on the PIC 16C71 *(from page 31)*

Listing 8*

```
; ***************************** reserve memory locations in RAM
                org     .12             ; "Base Address" of RAM
SaveWReg        res     1               ; store W context
SaveStatus      res     1               ; store Status context
AnalogReading   res     1               ; store ADC reading
; ***************************** Define Constants
W               equ     1
STATUS          equ     .3
ADCON           equ     .8
INTCON          equ     .11
Port_A          equ     .5              ; Port_A address
Port_B          equ     .6              ; Port_B address
; ***************************** Define Register Bits
GIE             equ     .7              ; Global Interrupt Enable
ADIE            equ     .6              ; ADC Interrupt Enable
PAGE            equ     .5              ; Register Page Selector
GO              equ     .2              ; ADC kick starter
CHS1            equ     .4              ; ADC Channel Selector (MSB)
CHS0            equ     .3              ; ADC Channel Selector (LSB)
ADCS1           equ     .7              ; Conversion Clock Selector Bit
ADCS0           equ     .6              ; Conversion Clock Selector Bit
ADON            equ     .0              ; ADC power control bit
ADIF            equ     .1              ; ADC interrupt flag
; ***************************** Application Specific Constants
IntBootVal      equ     .248            ; bits 7 through 4 =1 all interrupts enabled
DDRPortA        equ     ???             ; application dependent
DDRPortB        equ     ???             ; application dependent
; ***************************** Reset Boot Vector
Start           org     .0
                goto    InitCode
; ***************************** Interrupt Decoder and task director
IntVect         org     .4              ;  interrupt vector address
                movwf   SaveWReg        ; save the context of the W register
                swapf   STATUS,W        ; move status register into W
                movwf   SaveStatus      ; save the context of the Status register
                btfsc   ADCON,ADIF      ; skip next if not ADC interrupt
                goto    ADCHandler      ; NOTE: use of goto instead of call
                                        ; because we don't want to push PC on to the stack
                                        ; as we are going to return a value to Main
                btfsc   INTCON,RBIF     ; skip next if not bit delta on PortB Bits 4 through 7
                call    DeltaBitHandler
                btfsc   INTCON,INTF     ; skip next instruction if not edge on Port B bit 0
                call    ExtIntHandler
                btfsc   INTCON,RTIF     ; skip next if not RTC overflow
                call    TimerHandler
                retfie
ADCHandler      movf    ADRES,W         ; get reading ADC stashed here
                movwf   AnalogReading   ; save it in RAM
                retlw                   ; take the reading back to the main program
ExtIntHandler                           ; do external interrupt processing
                bcf     INTCON,INTF     ;<- Important to clear flag
                return                  ; return from interrupt
TimerHandler                            ; do timer interrupt processing
                bcf     INTCON,RTIF
                retlw   SomeValue       ; a literal you define
DeltaBitHandler                         ; do Port B bits 4 - 7  value delta  processing
                swapf   SaveStatus,W
                movwf   Status          ; restore context of Status register
                swapf   SaveWReg
                swapf   SaveWReg,W      ; restore context of W register
                bcf     INTCON,RBIF
                return                  ; return
InitCode                                ; this is where you set up how you want the chip configuration
                                        ; as well as initialize any and all variable that your program uses
                movlw   DDRPortA        ; Port A direction control
                tris    Port_A
                movlw   DDRPortB        ; Port B direction control
                tris    Port_B
                movlw   OptionVal
                option                  ; set up the option register
                movlw   IntBootVal
                movwf   INTCON          ; enable interrupts
MainCode                                ; This would be the main loop of your program that would start after
                                        ; the chip was fully initialized.
                btfss   INTCON,GIE      ; re-enable interrupts if they are not enabled
                bsf     INTCON,GIE      ; see the case of the ADCHandler
```

*This code presents the framework for the interrupt decoder for the hypothetical device that uses all PIC 'C71 interrupts. It presents samples of how to deal with a device that has multiple interrupts enabled. You can use sections of this code as a spring board for your own projects.



Details of the bits in the OPTION Register.

MOVLW/MOVWF pair of instructions to set up the ADCON register. The only *caveat* here is that you mustn't set the GO and ADON bits in the same instruction. The solution is to leave GO reset in your literal value and don't set this bit until you're ready to kick the ADC into motion. You'd use a BSF INTCON,GO instruction to set the bit.

Even though it isn't directly related to the task at hand, it's interesting to note that by modifying the values of the PCFG1 and PCFG0 bits in the ADCON1 register, you can split Port A into a variety of configurations. See Fig. 1, taken from the PIC 'C71 data sheet, for more information about this because it will most likely be relevant information if you plan to use the on-chip ADC. Keep in mind that you must set the PAGE selector bit in the STATUS register *before* you set any bits in the ADCON1 register. There are also several bits of interest in the ADCON register. For instance, to reduce power consumption, you can remove power from the on-board ADC until you need to run a conversion through the peripheral. I recommend that you study Fig. 2 (from the PIC 'C71 data sheet).

Recall that the PIC 'C71 vectors to 004h when it receives an interrupt stimulus. If you have only one interrupt source enabled, there isn't much to do, except process the code you've written to process the interrupt. Most of the time, this will be the case. But what about when you have every interrupt on the device enabled? Putting aside the fact that you'll be taxing the performance limits of the device, it's interesting to explore the topic as a worst-case scenario.

You can design your implementation by stripping out the parts you don't need in your particular application. But, for now, let's pretend that you've built a device that monitors for edges on Bit 0 of Port B and the lev-

Summary of PortB Registers

Register Name	Function	Address	Power-On Reset Value
PORTB	PortB Pins When Read; PortB Latch When Written	06H	XXXX XXXX
TRISB	PortB Data Direction Register	86H	1111 1111
OPTION	Weak Pull-Up On/Off Control (RBPU Bit)	88H	1111 1111

Summary of RTCC Registers

Register Name	Function	Address	Power-On Reset Value
RTCC	Timer/Counter Register	01H	XXXX XXXX
OPTION	Configuration & Prescaler Assignment Bits For RTCC	81H	1111 1111
INTCON	RTCC Overflow Interrupt Flag & Mask Bits	0BH	0000 000X

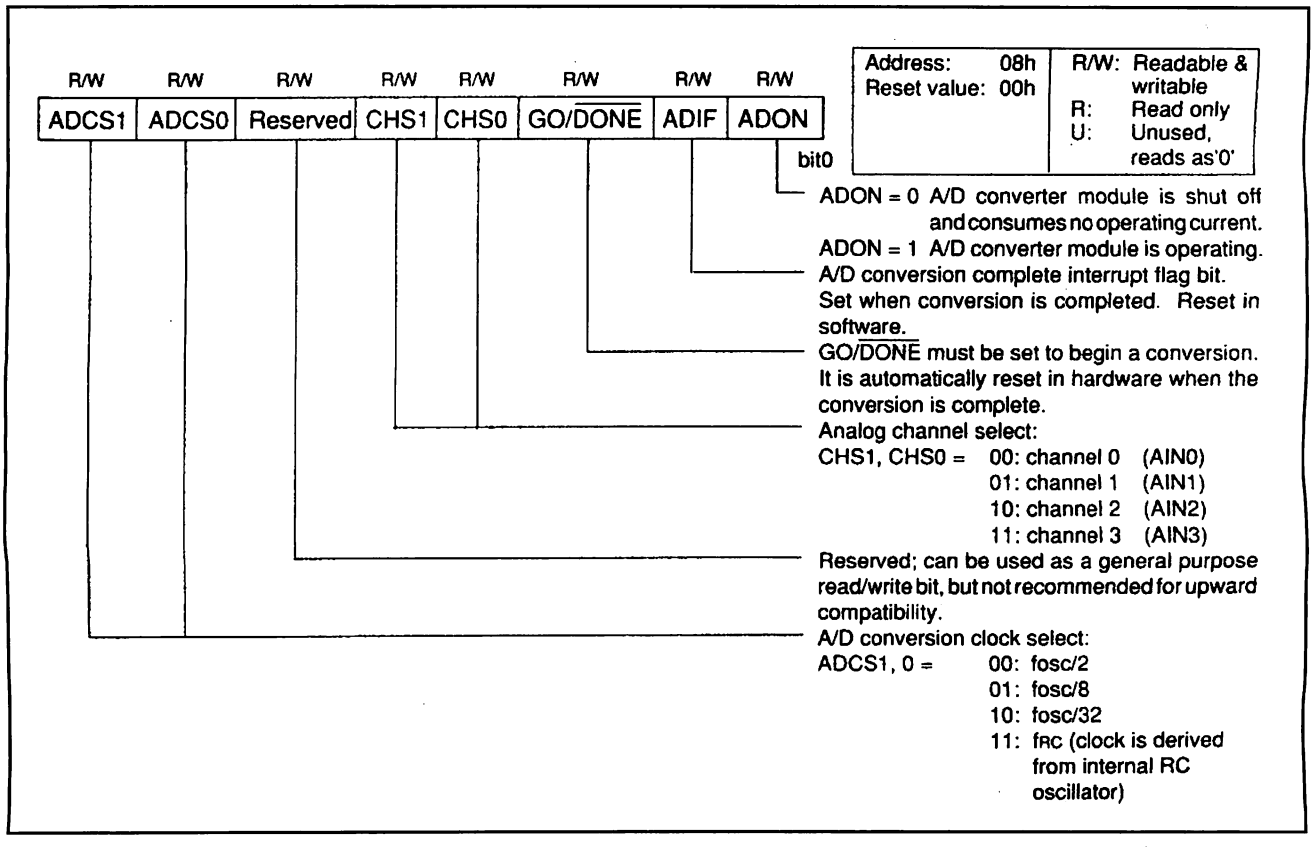
els of Bits 4 through 7 on Port B. In addition, our hypothetical device will read analog values on Port A and make use of RTCC. The code for this device is given in Listing 8. Since Listing 8 is provided for demonstration purposes only, I've deliberately omitted the code to initialize the interrupts. Refer to the appropriate listing for this information. You can lift pieces out of these program samples to do almost anything that's interrupt-driven on the PIC 'C71.

Cleaning Up

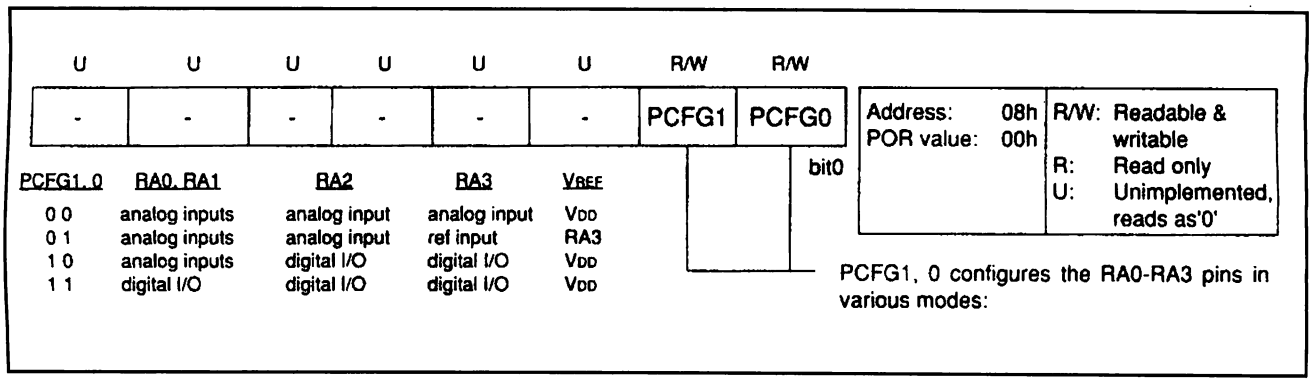
When the PIC 'C71 receives an interrupt, it performs a few quick actions. It immediately clears the GIE bit of the INTCON register. It also pushes the current state of the Program Counter onto the stack and then vectors to 004h. Clearing the GIE bit is designed to prevent recursive interrupts from occurring until you've had an opportunity to do something about the original interrupt. There isn't much left for your program to do, save one very important step. Just before you return from the interrupt handler, you must clear the appropriate interrupt flag. The chip will automatically clear this bit for you. So, if you don't clear this flag, you may trigger false recursive interrupts.

The reason that you must clear the appropriate flag is that...well, flags happen. What I mean is that the interrupt flags in the INTCON and ADCON registers are still active (they can change state) when the GIE bit is cleared, regardless of the state of their particular enable bit. Unless your code is designed to be recursive, or you have re-entrant interrupt handlers, you must be certain that the interrupt flag is cleared by your handler before you return. An example of this is given in Listing 8.

One technique I've used is to clear the flag upon entering the interrupt handler and then track the flag in my interrupt handler (with the GIE bit still cleared). As the last instruction before returning from the interrupt, I clear the flag. I could get away with this only because of the design of the program I was working on at the time. It's a trick you may want to keep in mind if you wish to implement a sort of fake recursion in which you'd re-trigger your handler on arrival of new interrupt stimulus without exiting and reentering your handler.



Details of the ADCON Register.



Details of the A/D Control Register,

The PIC 'C71 maintains an internal stack it uses to store the return addresses of an interrupt or a procedure CALL. Since the stack isn't addressable by your application, there isn't much you can do with it. You should be aware that it's only eight levels deep. Thus, you must be sure not to nest interrupts or procedures more than eight levels deep. With only 1K of program space, I don't think most programmers will ever need a deeper stack than this.

Since the stack isn't accessible, you may be wondering how you pass values from the interrupt handler. The answer is that you could use a global variable stored in a reserved RAM location. This is probably the most straightforward method. However, you could trick the processor into passing a return value in the W register. See Listing 8 for an example of this bit of wizardry.

Here's why it works. Normally when you return from an interrupt with an RETFIE instruction, one of the things that automatically occur is that the GIE bit is set. That is why it's important to clear the appropriate interrupt flag before using this instruction. But you can also pop the top address off the stack by using a RETLW instruction. This allows you to pass a value through the W register. But if you do this, you must manually set the GIE bit of the INTCON register, which can be more trouble than it's worth, unless you know exactly from where your code is interrupted. Otherwise, the return value can be pretty useless. Generally speaking, it's probably better to pass values through reserved RAM locations. But then again....

The final topic of concern when dealing with interrupts is saving the processor's context. Since only the program counter is pushed and popped on interrupts and returns, you must save any other registers of interest in your code. Fortunately, this is rather an easy thing to do. Listing 8 gives the steps you can perform to preserve the processor context.

Boot Me

I've covered a lot of ground here. I've shown you how to configure each of the interrupts available on the PIC 'C71 and methods for some advanced concepts, such as critical sections, return values from interrupts and processor context preservation. Everything was designed as a framework leading up to Listing 8. The other listings provide complete information on how to set up each particular interrupt. If you followed along with me, you should now be fully prepared to engage in all sorts of interrupt-based processing using the PIC 16C71 processor. ■

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Bits 'n' Pieces *(Continued from page 99)*

to you with *Chameleon*, it details how to install the software onto your hard disk, how to sign up for an Internet provider account and register the *Chameleon* software, connecting to the Internet and Web browsing with WebSurfer.

The remainder of the book consists of three parts. Part 1, Chapters 1 through 7, covers the procedures for connecting to the Web. Here you learn about Web browsers, *Lynx*, *SlipKnot*, *NCSA Mosaic*, the *Netscape* Navigator and other browsers.

Part 2 picks up from there and takes you through Chapter 19 with details on everything you need to know to create Web pages. You find out what you can do, the hypertext markup language, text, graphics, sound, interactivity, CGI scripts, other Web resources and much more.

Part 3, which consists of Chapters 20 and 21 and Appendices A through D, is titled Weaving a Web of Your Own. Chapters 20 and 21 cover such topics as where to place your HTML documents and starting your own Web site, respectively. The appendices cover Slip Internet providers, other software sources, Web help sources and details about the included CD-ROM.

I received this book about a month ago, and I'm still reading it—it's that interesting. I've learned a lot of things I didn't know and am certain to learn a lot more before I finish the book. From what I've read and skimmed over, I can form an educated opinion about this book. It's really good. It's well-written, well-illustrated and a very worthwhile addition to my library. If you're an Internet devotee, whether you're new to the Internet or a seasoned veteran, I think you'll agree with me. ■

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If you've ever forgotten a birthday or missed a meeting or appointment, *Excuses for Windows* from Procrastination, Inc. is for you. It may not remind you of an important event, but it can provide you with an amusing excuse when you forget it. *Excuses for Windows* contains a database of humorous and amusing excuses for almost every occasion. It's designed to work alone or with any *Windows* word processor. You can select from among many categories, including but not limited to "Missed Rent," "Jury Duty," and "Golf." Special categories are included for such professions as "Lawyers," "Stock Brokers," "Contractors" and many more.

Once you select a category, you can scroll through the excuses included. Alternatively, you can edit or enter your own excuse. Then just click and paste the excuse into your document. System requirements include an IBM PC/compatible computer with 4M of RAM, 2M of free hard-disk space, *Windows* 3.1 or later, a mouse and VGA or better video monitor. $29.95. *Procrastination Inc., PO Box 447, Hopewell, NJ 08525. Tel.: 609-466-7777; fax: 609-466-4116; e-mail:* 73062.3336@compuserve.com.

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Windows Remote Control Upgrade

CoSession for Windows Version 2.0 from Triton Technologies is a remote communications program that permits a PC in one location to remotely operate or access a second PC via modems, serial ports or network connections. Key enhancements include automatic configuration, instant accommodation of display differences between host and remote PCs, support for workstation to workstation connections and others. The package includes both host and remote software. $99. *Triton Technologies, Inc., 200 Middlesex Tpke., Iselin, NJ 08830; tel.: 908-855-9440.*

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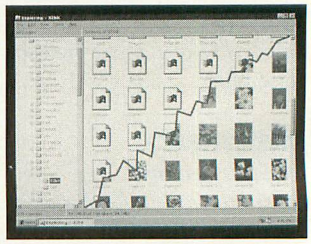
HiJaak 95 Upgrade

Inset's *HiJaak* 95 now integrates its graphics technology into the *Windows 95* shell, including creating and displaying 256-color thumbnails of 75 graphics formats in the Explorer, common Open dialog box, My Computer and Network Neighborhood. This permits you to view, organize, convert, trace and print graphics without having to run a separate application. The program extends the *Windows* Explorer Find feature with *HiJaak* Find, permitting Boolean searches on keywords, colors and other graphics attributes, as well as name, date and location from the Explorer or Start menu. $99. *Inset, 71 Commerce Dr., Brookfield, CT 06804; tel.: 203-740-2400; fax: 203-775-5634.*



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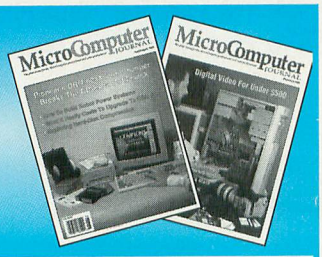

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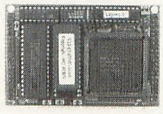

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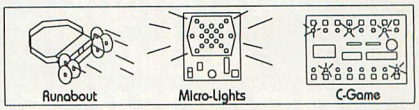

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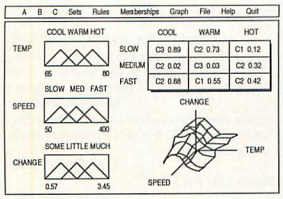

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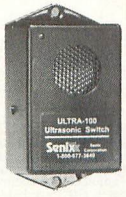

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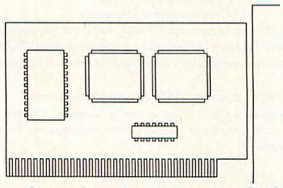

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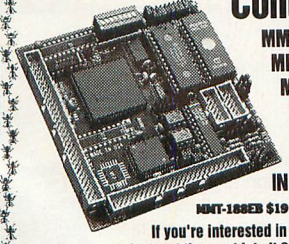

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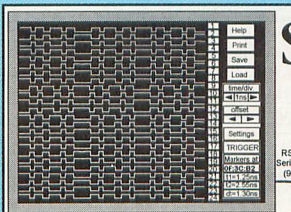

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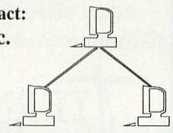

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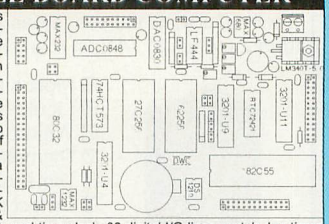

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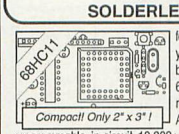

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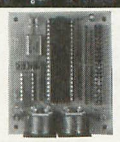

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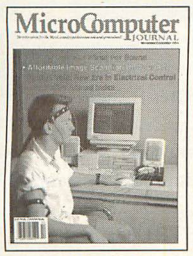

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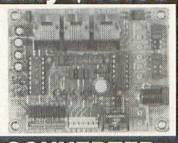

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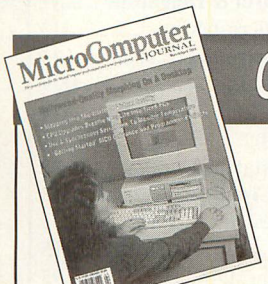

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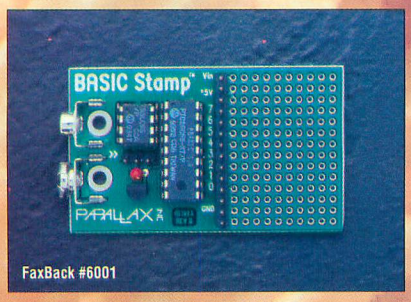

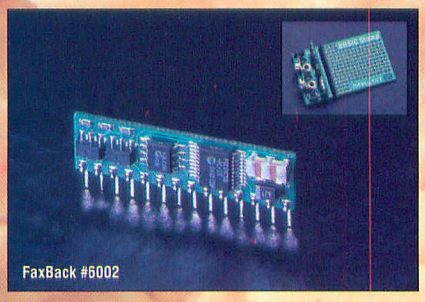

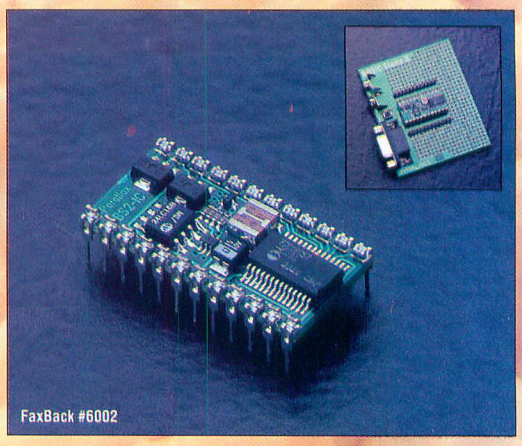

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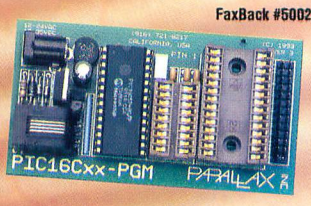

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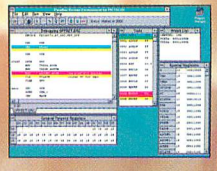

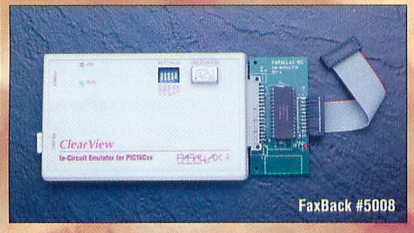

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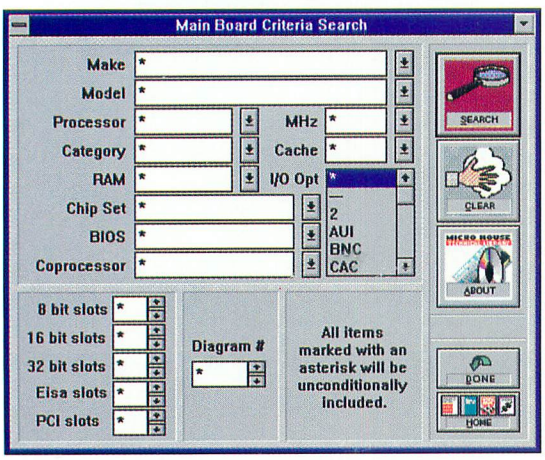

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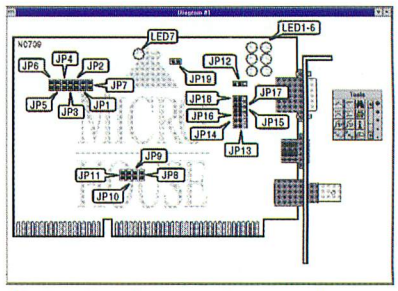

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